ESTABLISHING A LAN NETWORK FOR DESIGNING AND ANALYZING OF MANUFACTURING PRODUCTS

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ABSTRACT

ESTABLISHING A LAN NETWORK FOR DESIGNING AND ANALYZING OF MANUFACTURING PRODUCTS

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This Thesis covers the experimental study of a LAN network for the designing and analyzing of manufacturing products. In this study, a LAN composed of computers and network devices was established. The Windows 2000 Advanced Server was the network operating system of the LAN with Windows 2000 domain configured on the LAN. The Active Directory Service was installed and configured for managing the network and replications among domain controllers. The Distributed file system (Dfs) was installed on the LAN to manage the product information database. All of these network features provided a convenient and secure logic structure for product information management. Also, Mastercam8.1 and ANSYS5.7 were explored in this study. A product model was designed with Mastercam8.1 with the performance of the product under a moment force analyzed by using ANSYS5.7 in the simulation part of this study.

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CHAPTER I

INTRODUCTION

General Area of Concern

The 1990s brought a new shock to manufacturers with globalization of markets, increased competition, and expectations from customers to produce more models at lower prices and in less time. These changes forced manufacturers to address important questions such as: Could they afford long plant shutdowns for model changes and last-minute engineering change orders? Would they be able to turn new ideas gained directly from machines/processes and technicians into products and sell to a global economy quicker and at a lower cost than ever before? Faster, cheaper, better, soon became the goal of nearly every manufacturer competing in the global economy.

These challenges forced manufacturers to consider reengineering their business processes and adopting new methods to speed up the introductions of new models. Manufacturers implemented concurrent engineering procedures, product designers shared data with process designers, digital mock-ups replaced physical models, and many talked about a seamless process from design to production.

Manufacturing, worldwide, is definitely on the brink of some major transformations. Most of the transformations rely on the advanced information systems now being supported by networking technology and by the availability of the Internet. Networking technology will be a supportive solution for manufacturers to

their manufacturing procedures and information management. The Internet has become the biggest worldwide information provider and is a powerful tool for information transmissions. This transformation has also been enhanced by the development of web-based software applications created specially to manufacturers.

In this study, a LAN network, similar to the one shown in figure 1, will be designed and constructed. Within the LAN network, there will be several design workstations using Mastercam, a CAD/CAM software, and analysis workstations using ANSYS. The product data information database and the designers' communications will also be established in the network. The product modeling and analysis process will then be simulated on the network by designing and analyzing a certain manufacturing product. Finally, the whole network will be evaluated for its efficiency and capability.

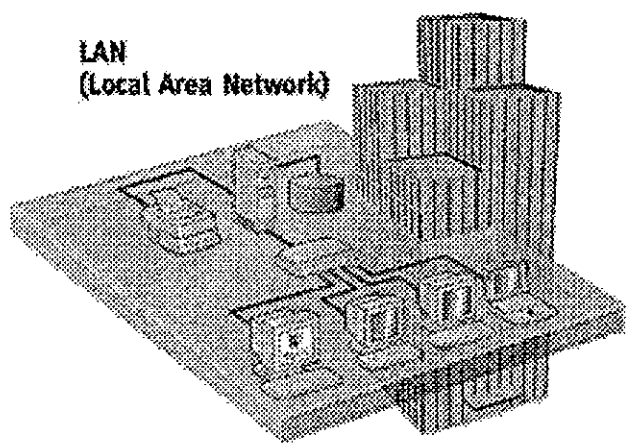


Figure 1. A LAN Model (Courtesy Cisco Company).

Objectives

1. Design a LAN network with several design and analysis workstations for product designing and analyzing in a manufacturing system.
2. Install Mastercam software on design workstations and ANSYS software on analysis workstations.
3. Apply Windows 2000 advanced server as the network-operating system to establish the product database server and to configure the security of the LAN network.
4. Simulate a certain manufacturing product modeling and analyzing process in the LAN network.
5. Evaluate the efficiency and security of the whole networking system, including the hardware and software systems.

Significance of the Study

The two critical processes in a manufacturing company are material flow process and information/data flow process. Material flow process is a visible and easily manageable process, while information/data flow process is an invisible and very complex process. However, the latter process is so important that it can actually determine the company's fate. It determines how soon the manufacturer can produce products, to meet the customers' changing needs, and how efficient the design and manufacturing process can be. So, establishing and maintaining a clear and manageable structure for the information/data flow process is a very important part of the modern manufacturers' goal in our information age.

In the information/data flow process will we continue to depend on paper documents and mails to keep information updated and exchanged among co-workers? It has been reported that an engineer normally spent 10 percent of his/her work hours locating the data needed. Although this has changed with the involvement of computers in the designing and manufacturing processes, how can this be implemented with remote information management, especially when data needs to be exchanged and updated over a very long distance? Of course, this is the role of networking! Networking technology is creating a magic world where people are exchanging information at an amazing speed. This allows organizations to save more money, and to improve the efficiency of the way their business is conducted. An organization with access to timely information has the means to make better-informed decisions which affect its markets, products and employees. The Internet, enterprise-wide networks, supply chain-wide networks, industry-wide networks and departmental networks have related access to enormous amounts of immediately needed and important information.

The LAN network, to be designed and constructed in this study, fits a factory network. It realizes the quick product modeling, the collaboration of designers and engineers, and the remote access using the following characteristics:

1. High speed: greater than 10 Mbps
2. Low cost: easily affordable on a computer and/or machine controller
3. High reliability/integrity: low error rates, fault-tolerance, reliable
4. Expandability: easily expandable to install new nodes

5. Installation flexibility: easily installed in an existing environment
6. Interface standard: standard interface across a range of computers and controllers

Definition of Terms

1. Network

   A network is a group of computers connected by cables or some method of wireless technology. It allows users to access large databases and centralized files, and to share information with each other.

2. LAN (Local Area Network)

   A LAN is a network that is confined to a 10-km distance (in practice, much shorter), in an office group, a building, a university campus, or a company. A LAN consists of software that controls data handling and error recovery, hardware that generates and receives signals, and media that carry the signal.

3. CAD (Computer Aided Design)

   CAD is a mechanical designing performed on a computer to create part geometry.

4. CAM (Computer Aided Machining)

   CAM is the process that produces toolpaths from CAD geometry and creates machine code for the CNC.

5. CNC (Computer Numerical Control)

   CNC is a computer technology for controlling machine tools, including milling machines. The CNC computer, referred to as a controller, feeds numerical data to the motors. The motor then use this data to physically move the table to cut the stock.

6. Mastercam

   Mastercam is a PC-based, mechanical CAD/CAM system that can be used to transfer the CNC code to the CNC controller.

7. ANSYS

   ANSYS is a general-purpose finite element modeling package for numerically solving a wide variety of mechanical problems. It is used to analyze product models in a real-world environment.

8. Manufacturing

   Manufacturing is the process of converting raw materials into products. It encompasses the design and manufacturing of goods, using various production methods and techniques.

9. Design Activities

   Product design is the first step of the manufacturing activity that deals with the conceptualization and planning of the physical and functional characteristics of a product. The purpose of manufacturing design is to study how to design a product so that manufacturing cost and time can be

reduced while preserving the functional requirements of a product (Chang, 1999; Wysk, 1999; Wang, 1999).

10. Windows 2000

    Windows 2000 is a network operating system that can function as a desktop operating system, print server, or application server. It is the newest network operating system from Microsoft.

Summary

Chapter one provided an introduction to the topic of this Thesis and addressed the concern. The objectives were stated and the significance of the study was expressed. Also, the terms to be used in the following chapters, and their definitions, were listed in the last part of the chapter.

CHAPTER II

REVIEW OF LITERATURE

Historical Background

Manufacturing is a set of correlated operations and activities, which includes product design, material selection, planning, production, inspection, management, and marketing of the product. A manufacturing system is an organization that is comprised of several interrelated manufacturing subsets. Its objective is to interface with outside production functions to improve their quality of both products and services. Manufacturers need to apply advanced technologies to optimize the manufacturing system, to improve the productivity, to optimize the total productivity performance of the system (Chang, 1999; Wysk, 1999;Wang 1999).

A couple of decades back manufacturers attempted to solve productivity problems by investing billions of dollars in CAD systems and automated production machinery. However, they only half-heartedly invested in automating the production engineering process, thereby creating a major manufacturing bottleneck.

In the 1980s, many companies tried new cures such as lean manufacturing, agile manufacturing, just-in-time manufacturing, and design for assembly. Some car manufacturers began experimenting with computer-aided production-engineering tools to simulate robot behavior on screen and to design robotic work cells. These companies began to use "what you see is what you get" visual displays to address a wide variety of production tasks, which normally would be determined once a plant

was nearly complete. These benefits led more companies to use tools for designing all aspects of manufacturing processes including assembly, machining, quality inspection, welding, painting, and ergonomics studies.

The 21st-century will undoubtedly be the knowledge-driven century, with information, which can be turned into knowledge and add value, representing more power than ever before. Networked computers provide the most powerful information system by connecting all the computers throughout the world. LANs, WANs, and the Internet together can comprise all kinds of networked information systems. The development of manufacturing will rely heavily on the construction of these effective information systems, in which product data flow and other information flow will be managed in structured and secure schemes.

Networking technology is more mature and more capable in its application in the manufacturing area since its first appearance in 1969. The first physical network was constructed in 1969, linking four nodes: University of California at Los Angeles, SRI (in Stanford), University of California at Santa Barbara, and University of Utah. The network was wired together via 50 Kbps circuits and could only transmit a few data files at the same time at a very slow speed. Now, with powerful servers and networking media, the network speed can be as high as 1 Gigabytes making it possible for multimedia with graphics and sounds to be transmitted online. The powerful servers can run huge numbers of applications at the same time and can also deal with amazing numbers of data files in just seconds, satisfying the manufacturers' need to manage the product data in a clear and quick way. The appearance of various

networking management applications, such as more and more advanced web-based PDM systems and online CAD packages, provides strong tools for applying networking in the manufacturing area.

Haven the technology background; it is reasonable to establish advanced information systems for the improvement of the manufacturing process. Also, with the ongoing efforts of experts and engineers, networking technology is constantly improving for more productive usage.

Manufacturing System

Manufacturing is a set of correlated operations and activities, which includes product design, material selection, planning, production, inspection, management, and marketing of the product, for the manufacturing industries (Wysk 1998). The wealth of any nation depends on its ability to retrieve natural resources and to manufacture goods. Although the efficiency of the distribution system and service system is important, the creation of goods is the most fundamental component of economic wealth.

A manufacturing system is an organization that comprises several interrelated manufacturing subsets. These subsets include design, manufacturing, planning/control and product. The design and planning/control subsets are the brains of the whole manufacturing system. Product design is the first step of the manufacturing activity and deals with the conceptualization and planning of the physical and functional characteristics of a product. Only detailed preliminary planning, which is the

legitimate control and feedback of the system, can guarantee the performance of a manufacturing system (Wysk 1998).

Design Activities for a Manufacturing System

1. Design conceptualization and function identification
2. Product modeling
3. Material selection
4. Design for efficient manufacturing
5. Dimensioning and tolerancing

Planning and Control Activities for a Manufacturing System

1. Material-requirements planning
2. Capacity planning
3. Facility and material-handling device planning
4. Inventory control
5. Tool management
6. Scheduling
7. Quality control
8. Manufacturing information management
9. Information and communication

Software Review

Mastercam8.1

In this study, Mastercam Version 8.1, a powerful CAD/CAM application will be used as a product design tool. It provides full 2D and 3D design capabilities, which

includes surface and solid modeling, for designing mechanical parts. From part models created in Mastercam, CNC codes ranging from 2 axes to 5 axes can be generated for manufacturing processes on Lathes, Machining Centers and Wire EDM machines. Mastercam's functionality in toolpath creation includes leftover machining, pencil tracing, flowline machining, scallop machining and the use of sub-programs. Mastercam can produce the geometric draft of product design, the toolpath of machining, and the CNC machine code. A perfect product model can be displayed to all designers, and the changes to the product can be made quickly. The Mastercam 8.1 environment is as shown in Figure 2.

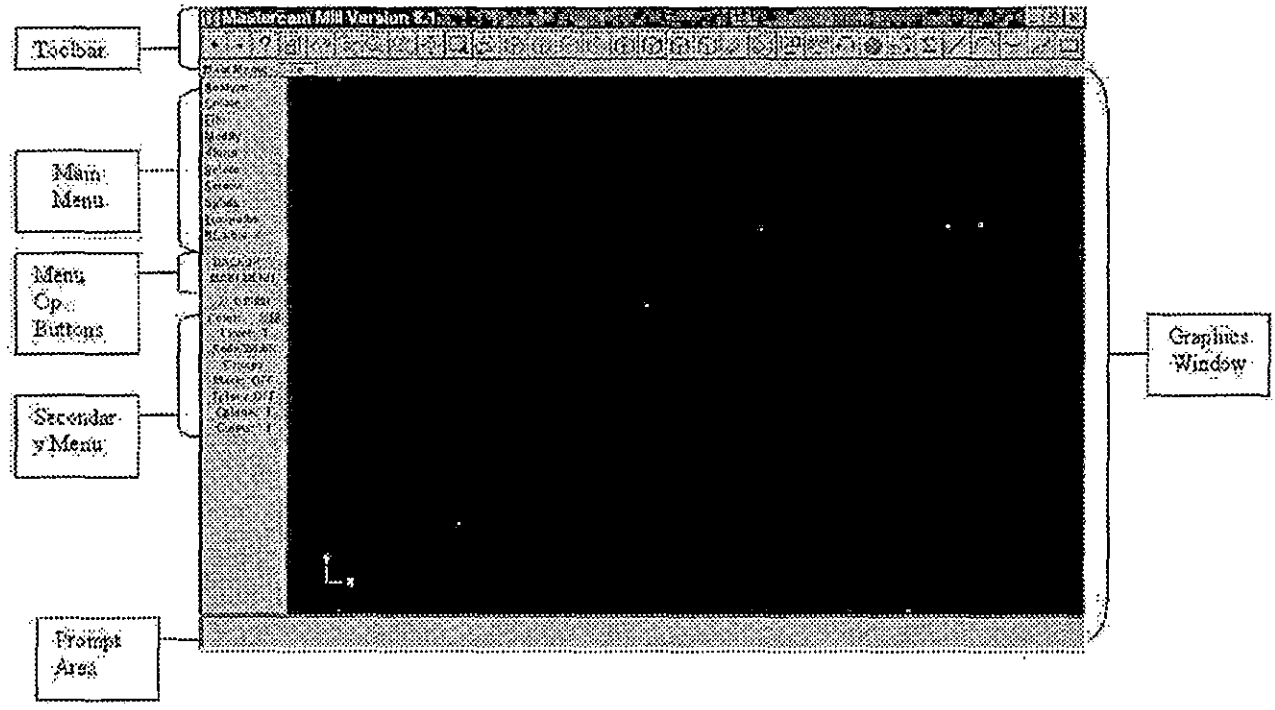


Figure 2. The Mastercam 8.1 Environment.

Mastercam interactions consist of menu choices, prompts, entity creations, and graphics window selections. In a typical sequence one navigates through the menu structure to a command, creates entities according to the prompts, makes parameter choices either in submenus or dialog boxes, then executes the command. Mastercam provides an Undo command so that errors can be corrected. Mastercam's main window consists of:

1. Main Menu

   The Main Menu is the top-level menu containing Mastercam's primary features, such as analyze, create, file... etc.

2. Secondary Menus

   A Secondary Menu is used to set current Z depth, drawing color, level, line and points styles, groups, level mask, tool, construction planes, and graphic view.

3. Graphics Window

   Graphics Window is the area where one creates and modifies geometry and generates toolpaths.

4. Prompt Area

   A Prompt Area displays information which requests data input.

5. Axes Markers

   The Axes Markers show the orientation of the X, Y, and Z axes in the current graphics view.

6. Toolbar

The Toolbar provides one-step access to Mastercam features.

ANSYS5.7

ANSYS is a software package used to solve various mechanical problems. These problems include: static/dynamic structural analysis (both linear and non-linear), heat transfer and fluid problems, as well as acoustic and electro-magnetic problems. In this study, ANSYS is used in analysis workstations to analyze a product's performance and capabilities in the real-world environment. By using ANSYS, one can predict a product's future performances, test any modeling changes, and solve problems before the production process. This saves time and money in product modeling and satisfying customers' needs in a timely fashion.

The ANSYS program has many finite element analysis capabilities, ranging from a simple, linear, static analysis to a complex, nonlinear, transient dynamic analysis. A finite element solution may be broken into the following three stages:

1. The Preprocessing stage defines the problem with the major steps:
    1) Define keypoints/lines/areas/volumes
    2) Define element type and material/geometric properties
    3) Mesh lines/areas/volumes, as required

    The amount of detail required will depend on the dimensionality of the analysis (i.e. 1D, 2D, axi-symmetric, 3D).

2. The Solution stage is used for assigning loads and constraints and solving equations. The loads (point or pressure) and contraints (translational and rotational) are specified and finally the resulting set of equationsis solved.
3. The Postprocessing stage includes further processing and viewing of the results. This stage can incude:
    1) Lists of nodal displacements
    2) Element forces and moments
    3) Deflection plots
    4) Stress contour diagrams

ANSYS also offers the following seven analysis types: static, modal, harmonic, transient, spectrum, eigenvalue buckling, and substructuring

There are two interface methods for using ANSYS. The first method is graphical user interface (GUI). This method follows the conventions of popular Windows and X-Windows based programs. The second method is command files. The command file approach has a steeper learning curve, but it has the advantage of describing an entire analysis in a small text file, typically in less than 50 lines of commands. This approach enables easy model modifications and minimal file space requirements. The ANSYS window environment is shown in Figure 3.

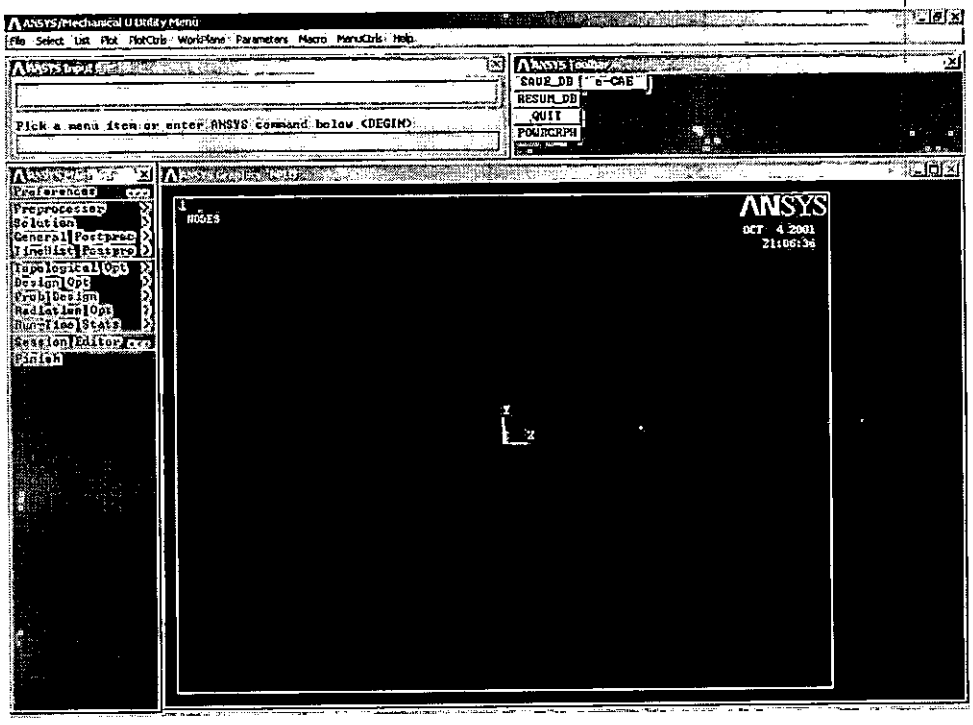


Figure 3. The ANSYS Environment.

The ANSYS main window consists of:

1. Utility menu

   The window at the top of the screen, displaying a long horizontal list of menu items, is referred to as the Utility menu. It contains functions that are available throughout the ANSYS session, such as file controls, selections, graphic controls and parameters.

2. Input window

   The Input Window shows program prompt messages and commands to be typed in directly.

3. Toolbar

   The Toolbar contains push buttons that execute commonly used ANSYS commands. More push buttons can be added.

4. Main Menu

   The Main Menu contains the primary ANSYS functions, organized by preprocessor, solution, general postprocessor, and design optimizer. It is from this menu that the vast majority of modeling commands are issued.

5. Graphics Window

   The Graphics Window is where graphics are shown and graphical selections can be made. This is where one graphically views the model in its various stages of construction and the ensuing results from the analysis.

6. Output Window

   The Output Window shows text output from the program, such as listing of data. It is usually positioned behind the other windows and can be placed in the foreground when necessary.

ANSYS Terms and Definitions

1. Boolean Operations

   Boolean Operations (based on Boolean algebra) provide a means of combining sets of data using such logical operators as add, subtract, intersect, etc. Boolean operations are available for volume, area, and line-solid model entities.

2. Direct Element Generation

   Defining an element by defining nodes directly.

3. Discipline

   Any of five physical (engineering) disciplines may be solved by the ANSYS program; structural, thermal, electric, magnetic, and fluid.

4. Element Options

   Many element types also have additional element options to specify such things as element behavior and assumptions, element results printout options, etc.

5. Higher-Order Elements

   Higher-order, or mid-side noded elements, have a quadratic shape function (instead of linear) to map degree-of-freedom values within the element.

6. Interactive Time Required

   This is an approximate range, in minutes, for you to complete the interactive step-by-step solution.

7. Jobname

   The file name prefix used for all files generated in an ANSYS analysis. All files are named Jobname.ext, where ext is a unique ANSYS extension that identifies the contents of the file.

8. Level of Difficulty

   Three levels are offered: easy, moderate, and advanced.

9. Material Properties

   These are physical properties of a material, such as modulus of elasticity or density, that are independent of geometry. Although they are not necessarily tied to the element type, the material properties required to solve the element matrices are listed for each element type. Depending on the application, material properties may be linear, nonlinear, and/or anisotropic.

10. Plane Stress

    A state of stress in which the normal stress and the shear stresses directed perpendicular to the plane are assumed to be zero.

11. Postprocessing

    The ANSYS analysis phase where the results of the analysis are viewed through graphics displays and tabular listings. The general postprocessor (POST1) is used to review results at one substep (time step) over the entire model. The time-history postprocessor (POST26) is used to review results at specific points in the model over all time steps.

12. Preprocessing

    The ANSYS analysis phase where data such as the geometry, materials, and element types are provided to the program.

13. Primitives

    Simple predefined geometric shapes provided by ANSYS.

14. Real Constants

These provide additional geometry information for element types whose geometry is not fully defined by its node locations. Typical real constants include shell thicknesses for shell elements and cross-sectional properties for beam elements.

15. Solution

The ANSYS analysis phase where analysis type and options are defined, loads and load options are applied, and the finite element solution is initiated.

16. Working Plane (WP)

WP is an imaginary plane with an origin, a 2-D coordinate system (either Cartesian or Polar), a snap increment, and a display grid.

Network Technology Review

Network Defined

A network is two or more computers connected to share resources such as files and printer. To function, a network requires a service to share or access a common medium or pathway and thus connect the computers. To bring it all together, protocols give the entire system common communication rules.

Open System Interconnection (OSI) Reference Model

The OSI model, as shown in Figure 4, takes a layered approach to a communication system in a manner similar to the layer of an onion. The lowest layer of the OSI model concentrates on the most basic concepts of data transfer. The

succeeding layers deal with progressively higher-order concepts until the final, or outermost layer, which involves the interaction of a user with the data communications system. The seven layers in the OSI model are: Physical layer, Data Link layer, Network layer, Transport layer, Session layer, Presentation layer, and Application layer (Robert 2001).

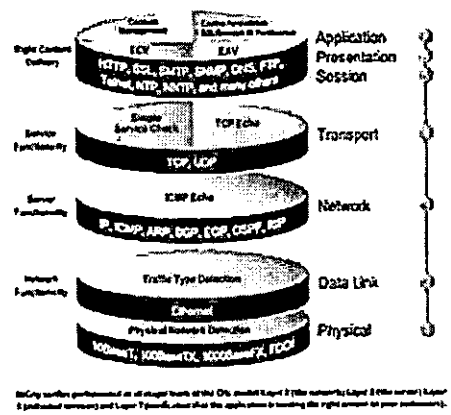


Figure 4. The OSI Model (Courtesy Cisco Company).

1. Physical layer

   The Physical layer handles physical signaling connectors, timing, voltages and other matter.

2. Data Link layer

   The Data Link layer is responsible for the transfer of data over the channel.

3. Network layer

   The Network layer is responsible for addressing and routing between subnetworks.

4. Transport layer

   The Transport layer ensures end-to-end error-free delivery.

5. Session layer

   The Session layer performs administrative tasks and security.

6. Presentation layer

   The Presentation layer provides for the representation of the data.

7. Application layer

   The Application layer is concerned with the support of end-user application processes.

Network Topologies

Topology refers to the physical arrangement or the architecture of the network. There are several types of topologies as shown in Figure 5.

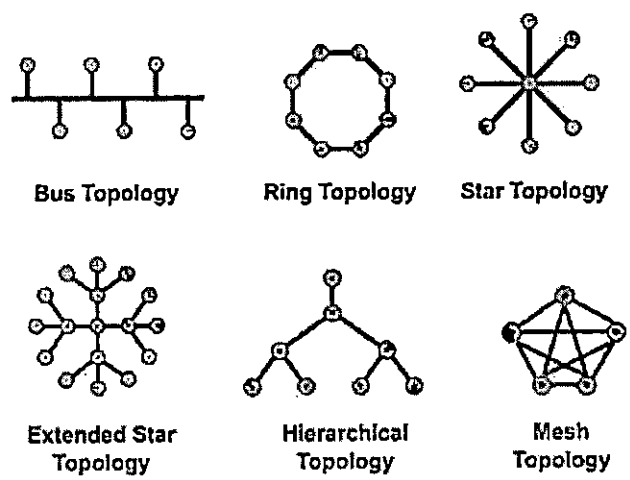


Figure 5. Network Topologies (Courtesy Cisco Company).

The following list contains the definitions of the four most common types of topology used in local area network.

1. Bus Topology

   A Bus Topology resembles a line, where data are sent along a single cable.

2. Ring Topology

   A Ring Topology has all devices connected together in a closed loop. Each device is connected directly to two other devices.

3. Star Topology

   A Star Topology is the most popular topology in use. It connects each network device to a central point, such as a hub, which acts as a multipoint connector.

4. Hybrid Topology

   The Hybrid Topology scheme combines two of the traditional topologies to create a larger topology. It allows users the strengths of the various topologies to maximize the effectiveness of the network.

Network Protocols

A protocol is a set of rules or standards designed to enable computers to connect with one another, and peripheral devices to exchange information with as little error as possible. A protocol suite is a set of protocols that works together to provide a full range of network services. The three categories for protocols used in networking technology and their definitions are listed below.

1. Internet protocols

   The Internet protocols route data packets between different hosts or networks, such as Internet Protocol (IP) and Router Information Protocol (RIP).

2. Host-to-Host protocols

   The Host-to-Host protocols maintain data integrity and set up reliable, end-to-end communication between hosts, such as Transmission Control Protocol (TCP), etc.

3. Process/Application Protocols

   The Process/Application protocols act as the interface for the user and provide applications that transfer data between hosts such as File Transfer Protocol (FTP), Post Office Protocol (POP).

Network Devices

There are several kinds of devices used to construct networks. The popularly used ones are explained below.

1. Repeaters

   Repeaters are devices used to extend the cable lengths of a single Ethernet network. They connect two or more segments together, thereby increasing the maximum distance of the segment. Most Ethernet hubs today are multiport repeaters.

2. Bridges

   Bridges work on the principle of a forwarding table using Media Access Control (MAC) addresses. They work by dynamically building a table of MAC addresses and defining on which network segment they belong. As a frame is received on a port, the source MAC address is identified and then added to the table.

3. Routers

   Routers operate at the Network layer of the OSI model. The Network layer is responsible for routing data between networks and is accomplished by using network addresses. Each protocol, which supports routing, uses it own method of defining network addresses. One goal of a router is to help quiet a network by completely separating the collision domains and the broadcast domains by not forwarding broadcasts. Advantages to using routers are that we can keep small broadcast and collision domains, and can easily do troubleshooting.

4. Switches

   Switches are similar to bridges, but they operate at a much faster rate. The latency through switches is dramatically reduced to the point where it almost appears as if the switch does not exist. In essence, switches work by internally creating connections between two or more ports.

LAN Technologies Used in the Study

In this study, a LAN network is designed and constructed using star topology with a hub. This LAN is a system of sharing product information inside the manufacturing system. The network protocol used inside the LAN is TCP/IP, and the access protocol used is CSMA/CD. The transmission medium used for this LAN is CAT5 UTP.

Star Topology in LAN

The star topology consists of a central hub with spokes extending out from it, and terminated in nodes. It is one of the lowest cost-per-node topologies. All that is required is to add another node to a hub port. The relative ease of adding nodes makes the star a good contender for networks with good growth opportunities. However, a hub must be installed with the ports ready to be plugged into. Star topology has low overhead and high throughput. The reliability of the star is directly related to the hub.

Access Protocols for LAN

CSMA/CD (Ethernet) is an access process to pass data, called Carrier Sense, Multiple Access, and Collision Detection. It was developed by Xerox in the 1970s and implemented in Ethernet. Although all nodes are directly attached to the physical media, only one node can safely transmit data at a time. The CSMA/CD protocol works in such a procedure. When the transmitter detects a data collision, it stops the transmitting. Then it sends a jam signal to assure that everyone knows there has been a collision. Each transmitter waits for a random amount of time and then transmits again.

TCP/IP Protocol

Protocols are the rules used for data communication within networks. In this study, TCP/IP is used as the LAN network protocol. TCP/IP stands for Transmission Control Protocol/Internet Protocol. It is the most popularly used protocol around the world, and is used as the protocol of the Internet.

The IP is defined at the network layer that is responsible for routing data to and from other networks. The IP defines the network address given to each host. The address can be broken into a network portion and a host portion, and the IP decides on the best route to get the data to its destination by using a routing table. The IP receives data in a segment form, and separates the segments into datagrams or packets in the process known as fragmentation. These fragments are then encoded and sent to the physical layer for distribution onto the physical medium.

The TCP is the reliable protocol of the TCP/IP suite. While IP sends data out to the network, it does not care if the datagram arrives. It is the TCP protocol that defines how to handle datagrams when they are lost or corrupted. Besides ensuring data delivery, TCP is also responsible for setting up the initial connections with the receiving host, and multiplexing data from multiple application layer protocols into a single connection. This multiplexing allows multiple applications to communicate with the same destination node more efficiently.

TCP/IP Addressing

TCP/IP uses a binary method of addressing at the Network layer. TCP/IP addressing is used to identify each host in networks. A host is any device that has a

network interface connected to a network, such as computers with NICs, routers, and network printers. Every host in a connected TCP/IP environment must have a unique TCP/IP address. A TCP/IP address is composed of four octets and every address can be broken down into two parts. The first part, Net ID, determines on which network the host resides. The second part, Host ID, refers to the actual host. The following TCP/IP address classes are used to designate the Net ID from the Host ID.

1. Class A

   The network portion consists of the first octet, while the host portion consists of the last three octets. The Subnet mask is 255.0.0.0.

2. Class B

   The network portion consists of the first two octets, while the host portion consists of the last two octets. The Subnet mask is 255.255.0.0.

3. Class C

   The network portion consists of the first three octets, while the host portion consists of the last one. The Subnet mask is 255.255.255.0.

4. Class D and Class E

   They are used for special purposes.

DNS Service

Domain name system (DNS) is a hierarchical client-server-based distributed database management system that translates Internet domain names into an IP address. The DNS clients are called resolvers and the DNS servers are called name

servers. In this study, DNS service is installed in the first domain controller of the Windows 2000 domain.

WINS Service

A Windows Internet Name Service (WINS) contains a database of IP addresses and NetBIOS (computer names) that update dynamically. It is used to resolve IP addresses to computer names for clients in a certain networking environment. In this study, the WINS service is also installed in the first domain controller of the Windows 2000 domain.

LAN Equipments Used in the Study

CAT5 UTP

Unshielded twisted pair (UTP) is the preferred cabling for LANs. UTP is classified by the EIA/TIA (Electronic Industry Association and Telecommunications Industry Association) according to categories. CAT5 UTP is used in this LAN network, and is the 22 or 24 AWG solid wire, twisted pairs. CAT5 cable has a characteristic impedance of 100 ohms and is specified for data rates up to 100 Mbps. This is the preferred cabling installation for Ethernet and Token Ring, and is recommended for all new installations. RJ-45 connectors are used for CAT5 cabling installation.

Cisco Hewlett Packard 10Base-T Hub-16M

The HP 10BaseT Hub-16M combines cost-effective LAN connectivity, security, and integrated management with Cisco IOS technologies. It has 16 10BaseT ports and one AUI port. One of the 10BaseT ports can be configured as either an MDI

or MDI-X port through a user-selectable switch on the front panel. It has built-in SNMP management, hub level and port level security, and support for Cisco Discovery Protocol (CDP) and StackMaker MIB. The hub can be monitored and managed graphically using CiscoWorks Windows, or via Telnet and out-of-band console. The HP 10BaseT Hub-16M also supports the optional external Cisco Redundant Power System (RPS). The HP 10BaseT Hub-16M supports the following standard features.

1. Sixteen 10BaseT ports and one AUI port for workgroup connectivity to coaxial or fiber Ethernet cable.
2. SNMP, Telnet, and terminal-based out-of-band management console support for comprehensive management and simplified troubleshooting.
3. Can be managed by CiscoWorks Windows and other SNMP-compatible management systems on a per-port and per-hub basis.
4. Hub-level and port-level security features including intruder prevention, auto port disabling, network management alarm, eavesdrop prevention, and password protection to prevent unauthorized network access.
5. Multifunction status LED per port for link integrity/receive activity, port enabled/disabled , and a collision, activity, security, and fault indicator for the hub that provides a comprehensive and convenient visual management system.
6. Automatically partitions and reconnects any ports experiencing excessive collisions to prevent network-wide disruption.

7. Cisco Discovery Protocol enables a CiscoWorks Windows network management station to automatically discover the device in a network topology.
8. MDI/MDI-X switch for inter-hub connectivity without special crossover cables.
9. An optional external Cisco Redundant Power System for improved fault tolerance and enhanced network uptime.
10. Cisco StackMaker for simplified device configuration, monitoring, and management of an entire system by CiscoWorks Windows.

LAN Operating System – Windows 2000

Introduction to Windows 2000

Windows 2000 is a multipurpose operating system with integrated support for client/server and peer-to-peer networks. Microsoft has released four editions of Windows 2000: Windows 2000 Professional, Windows 2000 Server, Windows 2000 Advanced Server, and Windows 2000 Datacenter Server.

Windows 2000 Professional

Windows 2000 Professional is a high-performance, secure-network client computer and corporate desktop operating system that incorporates the best business features of Windows 98 and builds in the traditional strengths of the Windows NT Workstation.

Windows 2000 Server

Windows 2000 Server is a file, print, and application server, as well as a Web-server platform, and contains all the features of Windows 2000 Professional, plus many new server-specific functions.

Windows 2000 Advanced Server

Windows 2000 Advanced Server is a more powerful departmental and application server operating system that includes the full feature set of Windows 2000 Server and adds the advanced high availability and improved scalability.

Windows 2000 Datacenter Server

Windows 2000 Datacenter Server is a specialized high-end version of Windows 2000 Server designed for large-scale enterprise solutions.

In this study, the LAN is prepared for manufacturing enterprise with the extension capability using the Windows 2000 Advanced Server operating system.

Features of Windows 2000

1. Lower total cost

   Reduces the cost of running and administering a network by providing automatic installation and upgrading of applications, and simplifies the setup and configuration of client computers.

2. Security

   Provides local and network security and auditing for files, folders, printers, and other resources.

3. Directory services

   Stores and manages Active Directory services information in the directory, which is the database that stores information about network resources.

4. Performance and scalability

   Supports up to four microprocessors.

5. Networking and communication services

   Provides built-in support for the most popular network protocols, including TCP/IP and IPX/SPX. Provides connectivity with Novell NetWare, UNIX, and AppleTalk. Provides dial-up networking that lets mobile users connect to a computer running Windows 2000.

6. Internet integration

   Integrates users' desktops with the Internet, thereby removing the distinction between the local computer and the Internet.

7. Integrated administration tools

   Provides the means to create customized tools to manage local and remote computers with a single standard interface.

8. Hardware support

   Supports Plug and Play hardware, which Windows 2000 automatically detects, installs, and configures.

Windows 2000 Architecture

To support the various functionalities, Windows 2000 is a modular system made up of a set of objects, which can be broken into two major layers, user mode and kernel mode.

User mode

The user mode layer of Windows 2000 is made up of a set of components referred to as subsystems. The subsystems insulate its end users and applications from having to know anything about kernel mode components. The user mode layer consists of environment subsystems and integral subsystems.

1. Environment subsystems

   Allow Windows 2000 to run applications written for different operating systems. These subsystems emulate different operating systems by presenting the application programming interfaces (APIs) that the applications need to be available.

2. Integral subsystems

   Perform essential operating system functions. Some important integral subsystems are Security, Workstation service, and Server service.

Kernel mode

The kernel mode layer of the Windows 2000 architecture has access to system data and hardware. Kernel mode provides direct access to memory and is executed in a protected memory area. It determines when a particular sequence of code is run by following prioritizing criteria. The kernel mode consists of several components with

well-defined functionality isolated in each component: the Executive, the Hardware Abstraction Level (HAL), and the set of kernel mode drivers.

1. Windows 2000 Executive

   The Executive performs most of the I/O and object management, including I/O manager, Security reference monitor, Virtual memory manager, and Process manager.

2. Hardware Abstraction Layer (HAL)

   The HAL virtualizes, or hides, the hardware interface details, making Windows 2000 more portable across different hardware architectures.

3. Kernel Mode Drivers

   Kernel mode drivers are implemented as discrete, modular components with a well-defined set of required functionality. All kernel mode drivers include a set of system-defined standard driver routines and some internal routines, depending on individual device requirements. The three basic types of kernel mode drivers are highest-level drivers, intermediate drivers, and lowest-level drivers.

Windows 2000 Active Directory Services

Active Directory services, the directory service included in Windows 2000, provides a single point of network management that allows easy addition, removal and allocation of users and resources. Active Directory services include the directory, which stores information about network resources, and all the services that make the information available and usable. Active Directory services organize resources

hierarchically in domains with the following three standard name formats being supported.

1. RFC 822: username@domainname
2. LDAP URLs and X.500:

   LDAP://servername.myco.com/CN=jimsmith,OU=sys,

   OU=product,OU=division,O=myco,C=US
3. Universal Naming Convention (UNC):

   \\servername.myco.com\xl\budget.xls.

Logical structure

The Active Directory Services organize resources in a logical structure, as shown in Figure 6.

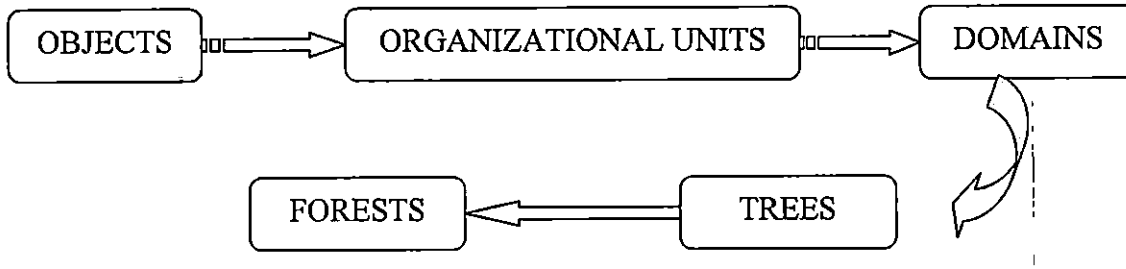


Figure 6. Logical Structure of the Active Directory Service.

The parts in the logical structure and their definitions are listed below.

1. Objects

   An object is a distinct named set of attributes that represents a network resource. Object attributes are characteristics of objects in the directory.

2. Organizational Units

   An organizational unit (OU) is a container object used to organize objects within a domain into logical administrative groups. An OU can contain objects such as user accounts, groups, computers, printers, applications, file shares, and other OUs.

3. Domains

   A domain is the core unit of the logical structure in Active Directory services. All network objects exist within a domain with each domain storing only the information about the objects it contains.

4. Trees

   A tree is a grouping or hierarchical arrangement of one or more Windows 2000 domains that allows global resource sharing. A tree can consist of a single Windows 2000 domain or multiple domains.

5. Forests

   A forest is a grouping of one or more trees. Forests allow organizations to group divisions (or two organizations to combine their networks) that do not use the same naming scheme, operate independently, and yet need to communicate with the entire organization.

Windows 2000 Domain

A Windows 2000 domain is a logical grouping of network computers that share a central directory database, as shown in Figure 7. A directory database contains user accounts and security information for the domain. In Windows 2000,

the directory database is known as the directory and is the database portion of Active Directory Services, that is the Windows 2000 directory service. In a domain, the directory resides on computers that are configured as domain controllers. A domain controller is a server that manages all security-related user/domain interactions and centralizes administration. A domain controller stores a replica of the directory partition (local domain database). All domain controllers in a domain have a complete replica of the domain's portion of the directory. When you perform an action that results in an update to the directory, Windows 2000 automatically replicates the update to all other domain controllers in the domain.

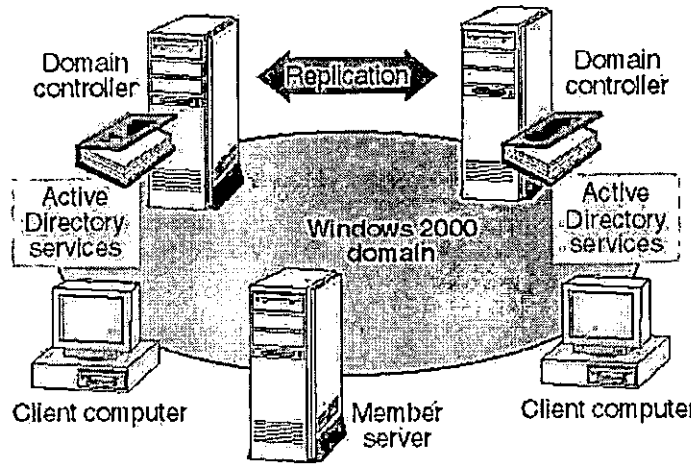


Figure 7. Windows 2000 Domain (Courtesy Microsoft).

Windows 2000 domains provide the following advantages:

1. A domain provides centralized administration because all user information is stored centrally.

2. A domain provides a single logon process for users to gain access to network resources, such as file, print, and application resources for which they have permissions. When they have permissions assigned, user can logon to one computer and access resources on another computer in the network.
3. A domain provides scalability that allows very large networks to be created.

Summary

In chapter II, the literature used for this Thesis was reviewed. Historical background of both manufacturing and networking were briefly described. The two packages to be used in the designing and analyzing process, Mastercam8.1 and ANSYS5.7, were introduced. Then the basics of network technology were reviewed with the LAN techniques and equipments to be used in the study being stated in detail. Finally, the operating system, which will be established and managed the whole information database, the Windows 2000 Advanced Server, was explained.

CHAPTER III

METHODOLOGY

Restatement of the Research Objective

The purpose of this thesis is to design and construct a LAN network used in product designing and analyzing activities of a mechanical manufacturing system. This study will also simulate a product modeling process in the LAN network, with evaluation of the efficiency and security of the LAN network.

Instruments Used

1. Gateway Pentium III computers
2. Cisco Hewlett Packard 10Base-T Hub-16M
3. CAT5 UTP
4. Mastercam8.1 CAD/CAM software Package
5. ANSYS5.7 software Package

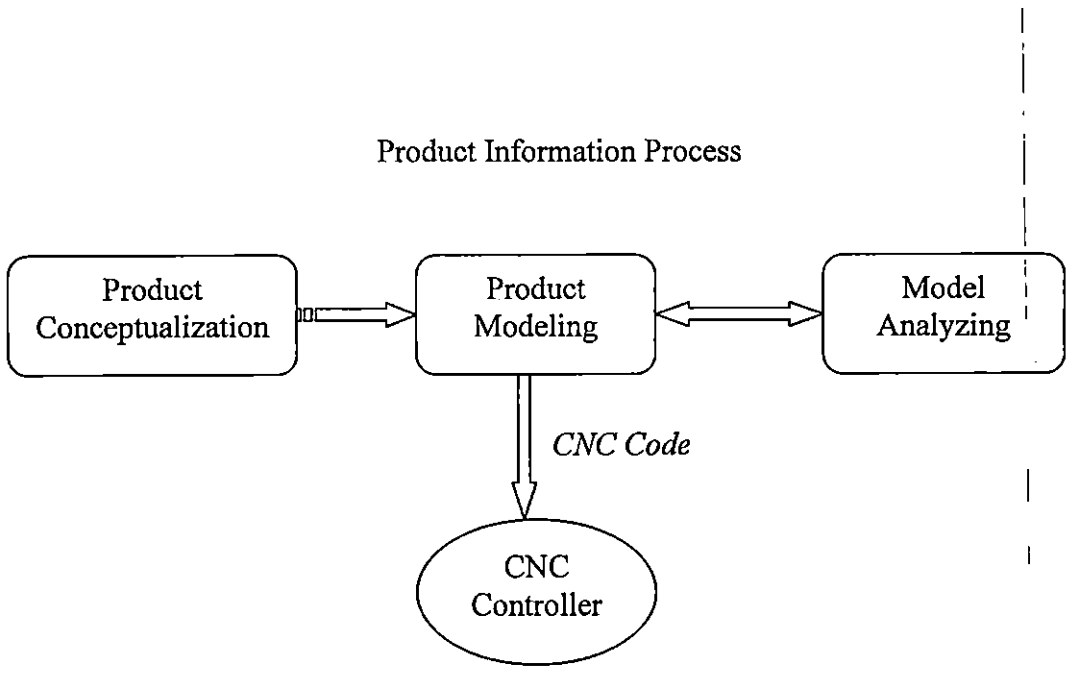


Figure 8. Product Information Flow.

The product information process in this Thesis is shown in Figure 8. Beginning with the design conceptualization, the designers will gather all the appropriate technical information about the proposed product. Then, the Mastercam8.1 software will be installed on each design workstation to establish the analytical and graphical representation of the product through product modeling. Once the design team approves the product model, the analysis engineers test the product model by using the ANSYS5.7 package stalled on the analysis workstation. The information about the product model's performance in testing is stored in the database server, as well as, displayed for each designer. The designers and engineers will then communicate with each other on the LAN about the refining of the product model. These brainstorming sessions will continue until the product model satisfies both the customers' needs and the manufacturing process. When an approved product model is accepted, Mastercam will automatically produce the CNC code of the model

and save it in the database. CNC controllers will retrieve the data and execute the code in the manufacturing process.

In conclusion, the product information flow is established and managed on the LAN network. The product information can be accessed and used by any designers and engineers with security rights to the project.

LAN Network Designing

The LAN is a Windows 2000 domain, consisting of two Domain Controllers, three designing workstations, and three analysis workstations. The Domain Controllers contain the database of LAN information and products information, as well as manage the whole network. The designing workstations, which have Mastercam8.1 installed, work as a design tool and a client for the server. The analysis workstations, which have ANSYS5.7 installed, allow the product information to be retrieved from the database and tested, saving the test results into the database. The LAN, which works as a part of the manufacturing system, provides a reliable and security channel for the product information flow. The detailed blueprint for the LAN is shown in Figure 9.

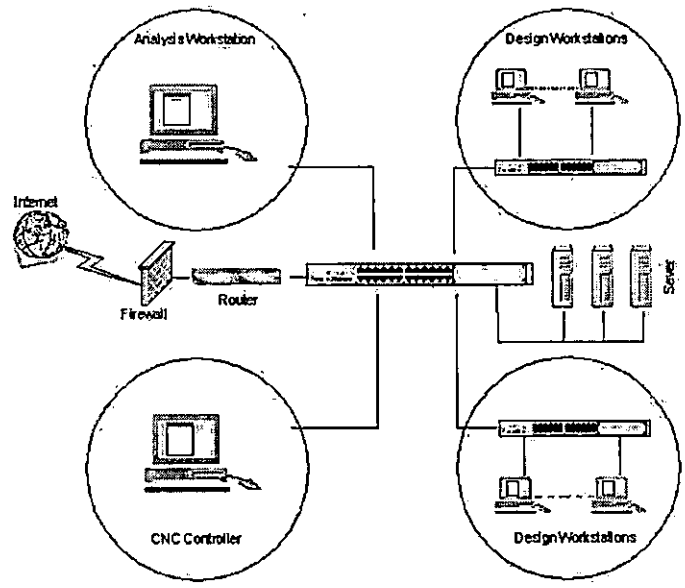


Figure 9. The LAN Blueprint.

LAN Network Constructing

Before the operating system installation, System Commander software is installed on each computer in the LAN. The System Commander software is used to manage the multi-OS systems in a computer. It allows several operating systems to be installed and running in separate partitions without affecting each other. This is the safest way to partition and install new operating systems in a computer. When the System Commander is installed, the Windows 2000 Advanced Server is then installed in each computer using the System Commander. Windows Advanced Server Installation Procedure is below.

The System Commander OS Wizard Prepares a Partition for Windows 2000

1. As the computer boots into the System Commander, press *Alt-O* to enter the System Commander OS Wizard.
2. Specify the type of OS installation by choosing: *New installation.*
3. Select the OS type to install by choosing: *Windows.*
4. Select the specific Windows by choosing: *Windows 2000.*
5. Select the edition of Windows 2000 by choosing: *Regular.*
6. Select the way to install by choosing the item: *Isolated by itself.*
7. Specify the space to install Windows 2000 by entering the number: *2500MB.*
8. Then the OS Wizard prepares for the new OS installation. It takes several minutes to wait for the partition preparation.
9. OS Wizard completes. Click *OK.*
10. Insert the Win2000 Advanced Server CD before restarting the computer.

Windows 2000 Setup Prepares for The Installation

1. The computer boots from Win2000 Advanced Server CD.
2. Three items display on the screen:

   Setup Win2000 Professional
   Setup Win2000 Server
   Setup Win2000 Adv Server

   Select *Setup Win2000 Adv Server* to boot computer from CD.
3. Window 2000 Setup loads Setup files to the hard drive of the computer.

4. The *Welcome to Setup* Screen appears. Press *Enter* to setup Windows 2000 now.
5. *Windows 2000 Licensing Agreement* appears. Press *F8* to agree.
6. A partition for the Windows 2000 installation is prepared when setting up the System Commander. In the *Win2000 Server Setup* Screen, select the item: *Select the existing partition to format.* Then specify the existing partition by clicking on it.
7. In the *Win2000 Server Setup* Screen, specify the file system by selecting: *Format the partition with NTFS file system.* Select the NTFS file system to provide security for the LAN.
8. Win2000 Server Setup formats the selected partition with the NTFS file system.
9. Win2000 Server Setup examines the formatted partition.
10. Win2000 Server Setup copies files to the Windows 2000 installation folders.
11. Win2000 Server Setup initializes Windows 2000 configuration.
12. Remove the Windows 2000 Adv Server CD from the CD-ROM and restart the computer.

Running Windows 2000 Setup Wizard

1. Insert Windows Adv Server CD before the computer boots. The computer boots from the System Commander. In the OS Selection Menu, select *Windows NT* to boot into the Windows Adv Server Setup Wizard.

2. Win2000 Adv Server Setup detects and installs devices on the computer.
3. The Setup customizes regional settings for the computer.
4. In the Setup Wizard, enter user name and the company name.
5. Enter the product key for the Win2000 Adv Server system.
6. In the *Setup* Wizard, there are two licensing mode: Per Server or Per Seat. For now, select the *Per Server* mode, and specify the number of current connections as 20. More clients can be added to the LAN in the future as needed.
7. In the *Setup* Wizard, enter the computer name and Administrator password.
8. In the *Windows 2000 Components* window of the Setup Wizard, components can be added or removed.
9. Set the correct date and time in the *Setup* Wizard.
10. The *Win2000 Setup* Wizard installs networking settings.
11. There are two kinds of settings for installing: *Typical Settings* and *Custom Settings*. Select *Custom Setting* to install. In *Custom Setting*, select a set of network components for the computer. Also, specify the IP addresses for each computer, DNS, WINs, and default gateway.
12. The Wizard is now prompts you to join a workgroup or a domain. At this point, choose to join in a workgroup. The domain can be figured later.
13. The *Setup* Wizard installs the components.

14. The *Setup* Wizard performs the final tasks.

Installs Start menu items
Registers components
Saves settings
Removes any temporary files used

15. Complete the *Windows 2000 Server Setup* Wizard. Click *Finish.* Remove the CD from CD-ROM drive and restart the computer.

Then repeat the steps above to install the Windows 2000 Adv Server system on every computer in the LAN. After installing the operating system on each computer, connect the computers to the Cisco HP 10BaseT Hub-16M by CAT5 UTP cables. Physically, a LAN is constructed with the star topology. At this point, all the computers are stand-alone units in the same workgroup. None of them can act as a server without the LAN is configured.

LAN Configuration

Establishing the First Domain Controller

The Windows 2000 domain is established with the establishment of the first Domain Controller of the domain. To establish the domain, set up and configure the first Domain Controller on one of the Windows 2000 Adv Servers in the LAN.

The first Domain Controller is actually configured with the installation of the Active Directory Service and DNS (Domain Name System) in the Win2000 Server. The Active Directory Service (ADS) is completely integrated with the Windows 2000 server and offers hierarchical view, extensibility, scalability, and distributed security. The ADS allows administrators, developers, and end users to access a directory

service that is seamlessly integrated with both Internet and intranet environments. It uses the Internet Domain Name System (DNS) as its locator service, and organizes objects in domains into a hierarchy of organizational units (OUs). Following are the procedures, which were followed in this study, to install the ADS and DNS and to configure the first Domain Controller for the domain.

Promote The Stand-alone Server IET-2B to A Domain Controller

1. Start IET-2B and logon as Administrator with a password.
2. Click *Start* > *Programs* > *Administrative Tools* > *Configure Your Server*.
3. The *Windows2000 Configure Your Server* window appears. Click *Active Directory*.
4. The window indicates that the Active Directory Installation wizard will configure this server as a domain controller and set up DNS on it. Scroll down and click *Start*.
5. The *Active Directory Installation* wizard appears as shown in Figure 10. Click *Next*.

Figure 10. Active Directory Installation Wizard.

6. The *Domain Controller Type* page appears as shown in Figure 11. Be certain the *Domain controller for a new domain* radio button is selected. Click *Next*.

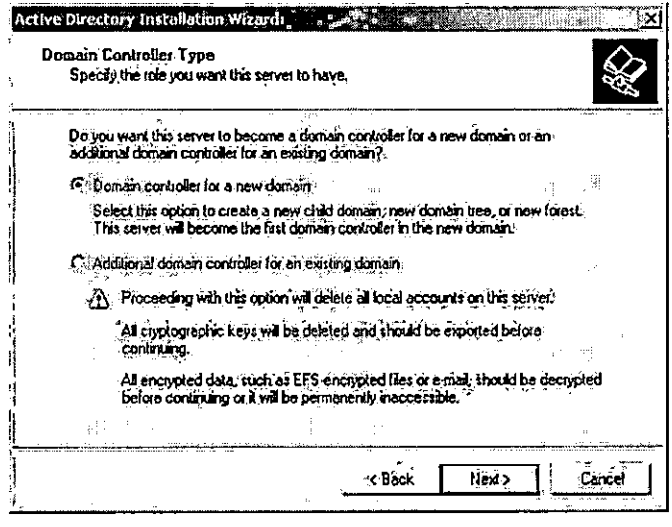


Figure 11. Domain Controller Type Page.

7. The *Create Tree or Child Domain* page appears as shown in Figure 12. Be certain the *Create a new domain tree* radio button is selected. Click *Next.*

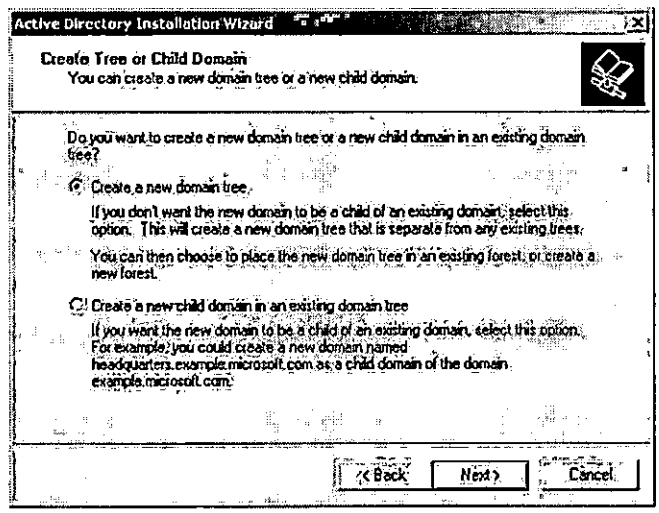


Figure 12. Create Tree or Child Domain Page.

8. The *Create or Join Forest* page appears as shown in Figure 13. Be certain the *Create a new forest of domain trees* radio button is selected. Click *Next.*

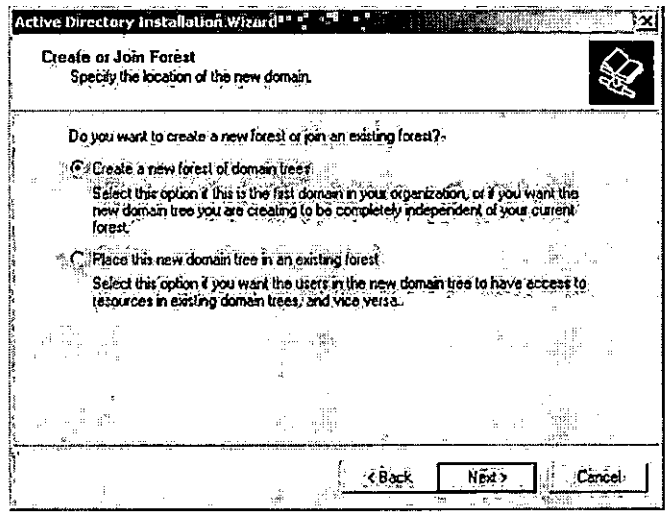


Figure 13. Create or Join Forest Page.

9. The *New Domain Name page* appears. In the *Full DNS name for new domain* box, type the name for the new domain: *Project.com* as shown in Figure 14. Click *Next*.

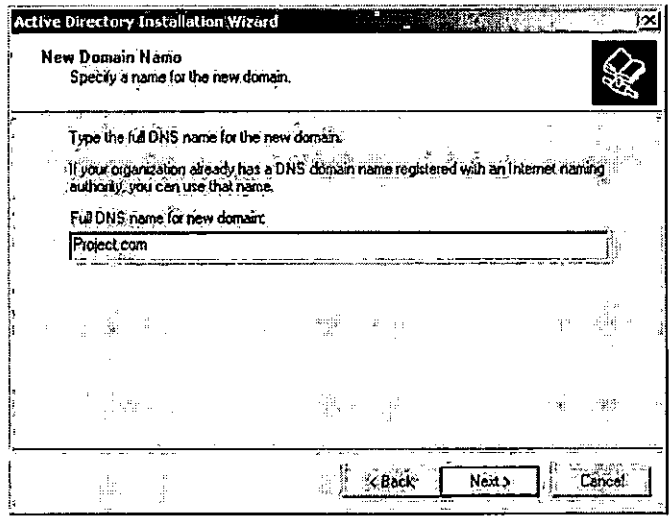


Figure 14. New Domain Name Page.

10. The *NetBIOS Domain Name* page appears as shown in Figure 15. The default NetBIOS name of the new domain is *PROJECT*. Click *Next*.

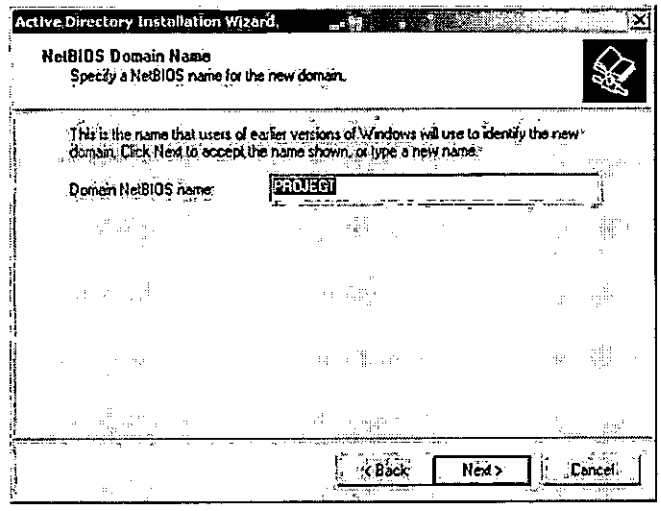


Figure 15. NetBIOS Domain Name Page.

11. The *Database and Log Locations* page appears as shown in Figure 16. Click *Next* to accept the default location: C:\WINNT\NTDS.

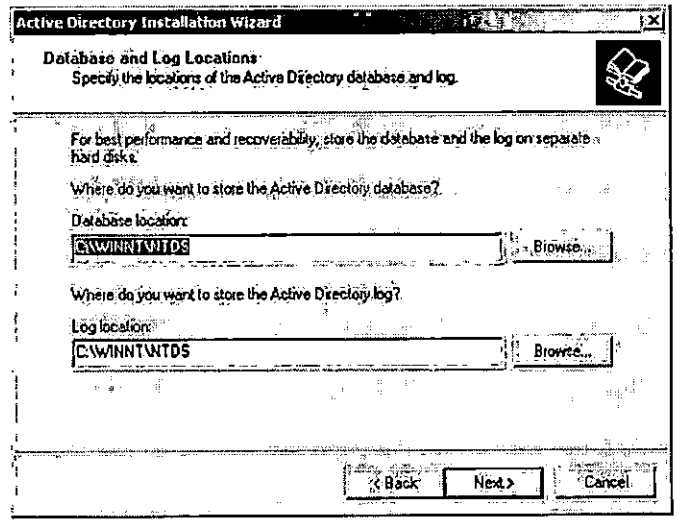


Figure 16. Database and Log Location Page.

12. The *Shared System Volume* page appears as shown in Figure 17. Click *Next* to accept the default location: C:\WINNT\SYSVOL.

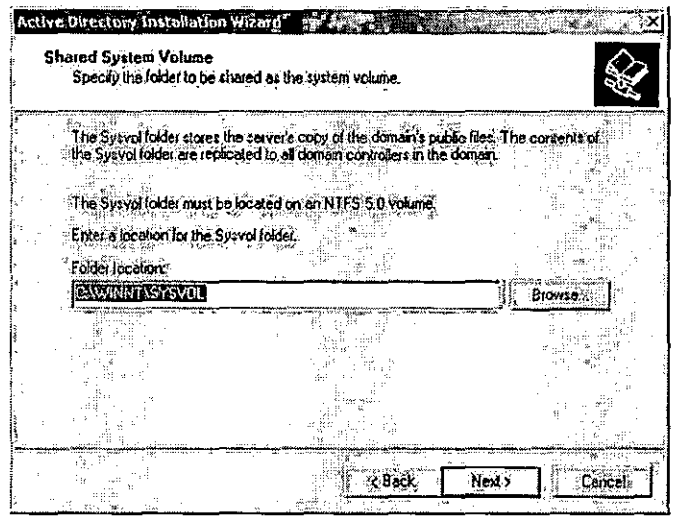


Figure 17. Shared System Volume Page.

13. A message appears indicating that a DNS server cannot be contacted. Because this computer is the first domain controller and DNS server of the domain, click *OK*.
14. The *Configure DNS* page as shown in Figure 18. Be certain the *Yes, install and configure DNS on this computer (recommended)* radio button is selected. Click *Next* to configure DNS.

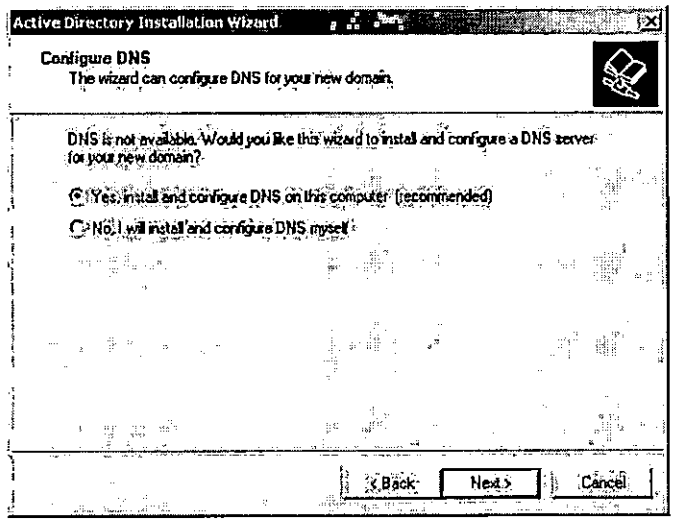


Figure 18. Configure DNS Page.

15. The *Permissions* page appears as shown in Figure 19. Click the *Permissions compatible only with Windows 2000 Servers* radio button to allow only Win2000 servers/clients to access this domain. Click *Next*.

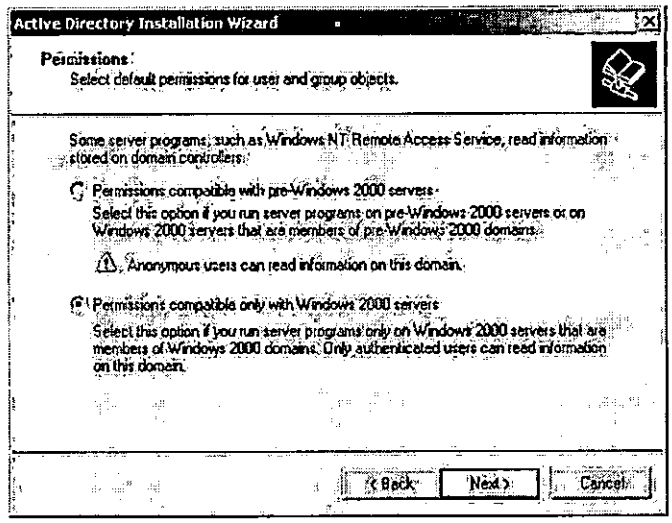


Figure 19. Permissions Page.

16. The *Directory Services Restore Mode Administrator Password* page appears as shown in Figure 20. Type and confirm the password to use

when restoring Active Directory. Record the password in a secure location. Click *Next*.

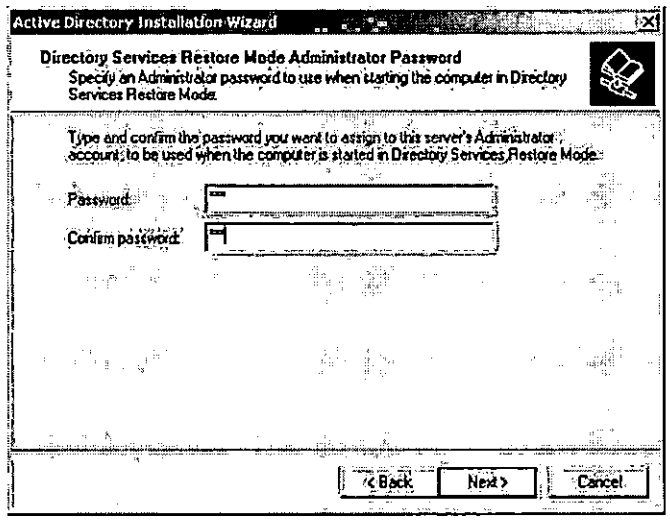


Figure 20. Directory Services Restore Mode Administrator Password Page.

17. The *Summary* page appears as shown in Figure 21. The selected configurations for this server are listed. Click *Next*.

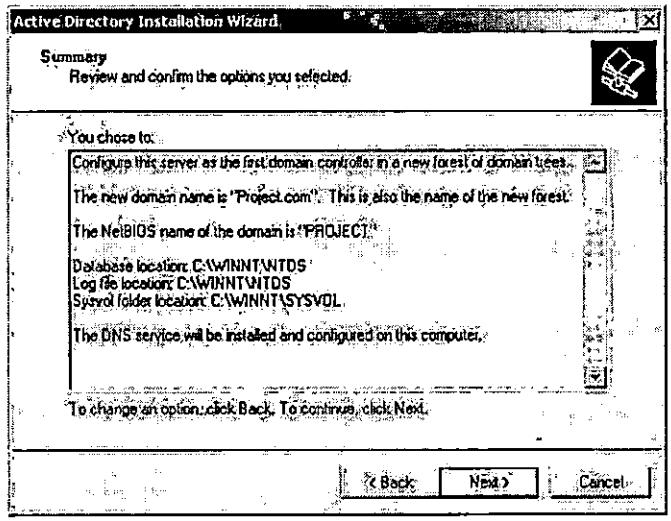


Figure 21. Summary Page.

18. A *Configuring Active Directory status* screen appears as shown in Figure 22 indicating the process of configuration.

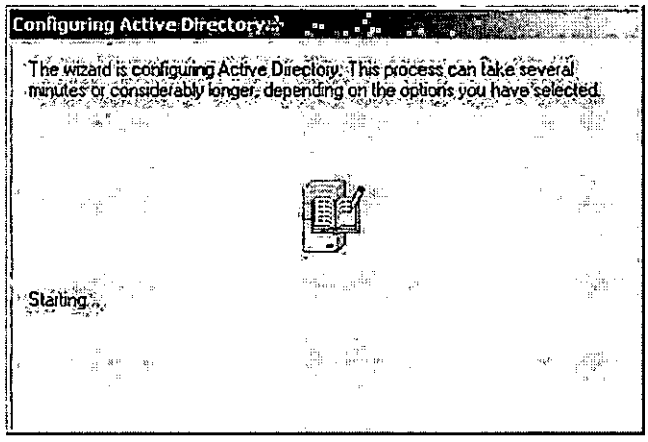


Figure 22. Configuring Active Directory Status Screen.

19. When the *Completing the Active Directory Installation* Wizard page appears, click *Finish*. A message should appear indicating that the computer needs restarted.
20. Click the *Restart Now* command button to restart the computer.

Verify The Creation of The New Domain

1. Logon to the new domain as the administrator account.
2. Click *Start* > *Programs* > *Administrative Tools* > *Active Directory Domains and Trusts*. The new domain is in the console tree as shown in Figure 23.

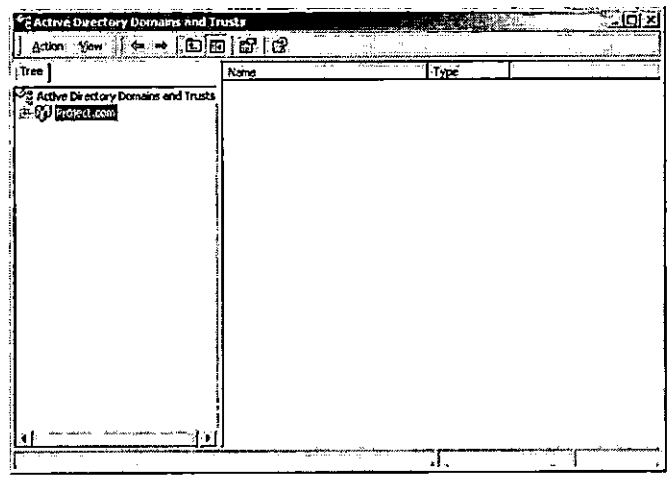


Figure 23. Active Directory Domains and Trusts Window.

Manually Specify The IP Configuration

A new domain was established with the following configurations.

Domain name:	Project.com
Domain NetBIOS name:	PROJECT
Computer name of the domain controller:	IET2B
Full name of the domain controller:	IET-2B.Project.com

The other computers were added in the domain by specifying the specific IP addresses to this domain controller, the default gateway, the DNS server, the WINs server, and the subnet mask. There is no DHCP server used in the domain, the IP settings were manually configured for the domain controller and all other computers in this domain using the following procedure.

1. Logon to the domain as administrator account with a password.
2. Right click on *My Network Places* icon and select *Properties* from the menu. The *Network and Dial-Up Connections* window appears.

3. Right click on the *Local Area Connection* icon in the window to open the *Local Area Connection Properties* window.
4. In the *Local Area Connection Properties* window, there is a box named Components checked are used by this connection. Highlight the item: *Internet Protocol (TCP/IP)*, then click on *Properties* button.
5. The *Internet Protocol (TCP/IP) Properties* window appears. Click on the *Use the following IP Address* radio button.
6. In the *IP Address* box, type in: *192.168.0.8*. In the *Subnet mask* box, verify that *255.255.255.0* appears. In the *Default gateway* box, type in: *192.168.0.8*.
7. Click on the *Use The Following DNS Server Addresses* radio button. In the *Preferred DNS Server* box, type in: *192.16.0.8*.
8. The *Internet Protocol (TCP/IP) Properties* window is shown in Figure 24.

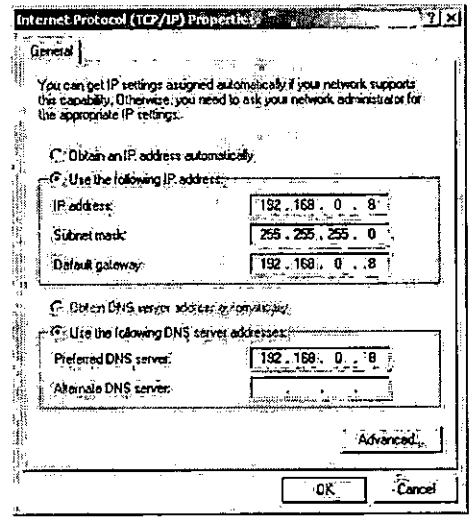


Figure 24. Internet Protocol (TCP/IP) Properties Window.

As shown above, the C class IP addressing is used in this domain. And this first domain controller also acts as the default gateway, the DNS server and the WINS server for this domain.

Create the Second Domain Controller

An additional domain controller was created in the existing domain Project.com. The additional domain controller participates equally as the first domain controller in the Active Directory replication. It provides a redundant backup for the domain, so the domain can function properly even if the first domain controller becomes corrupt. The following procedure was used to configure the second domain controllers.

Manually Configure The IP Addressing

The second domain controller should be in the same subnet with the existing domain controller. It should also use the DNS and WINS services provided by the existing domain controller.

1. Logon to the IET-3B computer, with the administrator account, to add it to the domain as an additional domain controller.
2. Right click on *My Network Places* icon and select *Properties* from the menu. The *Network and Dial-Up Connections* window appears.
3. Right click on the *Local Area Connection* icon in the window to open the *Local Area Connection Properties* window.
4. The components checked are used by this connection, only highlight the item: *Internet Protocol (TCP/IP)*, then click on *Properties* button.

5. In the *Internet Protocol (TCP/IP) Properties* window (Figure 25), click on the *Use the following IP Address* radio button.
6. In the *IP Address* box, type in: *192.168.0.7*. In the *Subnet mask* box, verify that *255.255.255.0* appears. In the *Default gateway* box, type in: *192.168.0.8*.
7. Click on the *Use The Following DNS Server Addresses* radio button. In the *Preferred DNS Server* box, type in: *192.16.0.8*. Click *OK*.

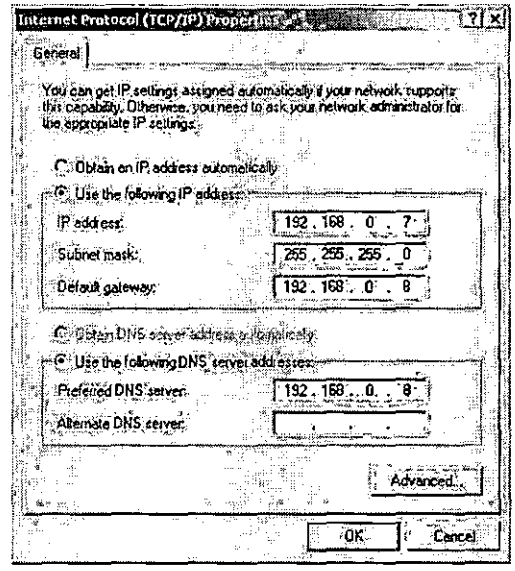


Figure 25. Internet Protocol (TCP/IP) Properties Window.

Create The Second Domain Controller

1. Click *Start* > *Programs* > *Administrative Tools* > *Configure Your Server*. The *Configure Your Server* window appears as shown in Figure 26.

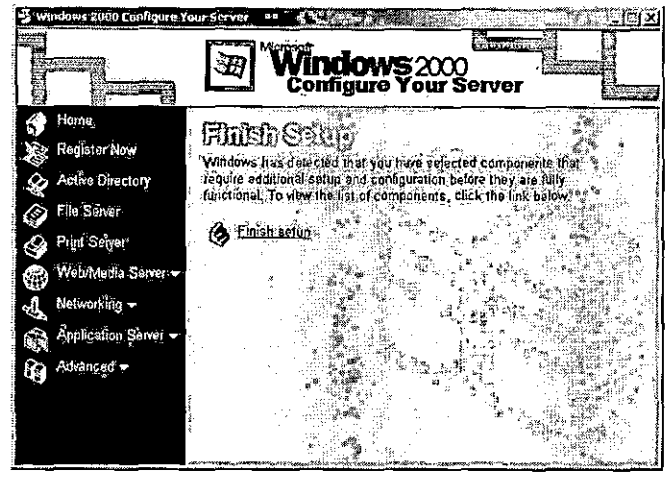


Figure 26. Configure Your Server Window.

2. Click *Active Directory* in the left column. Scroll down and click on *Start*.

3. The *Active Directory Installation* wizard appears as shown in Figure 27. Click *Next*.

Figure 27. Active Directory Installation Wizard.

4. The *Domain Controller Type* page appears as shown in Figure 28. Click the *Additional domain controller for an existing domain* radio button. Click *Next*.

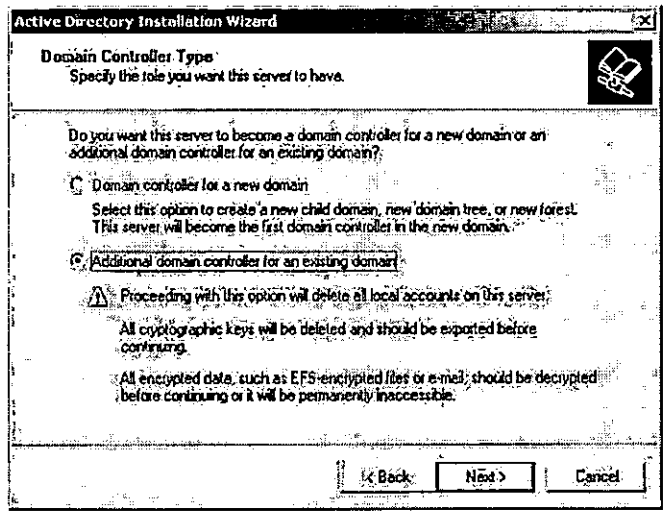


Figure 28. Domain Controller Type Page.

5. The *Network Credentials* page appears as shown in Figure 29. Type the name and password for the administrator account of the domain. In the domain box, type the name of the domain, *Project.com*. Click *Next*.

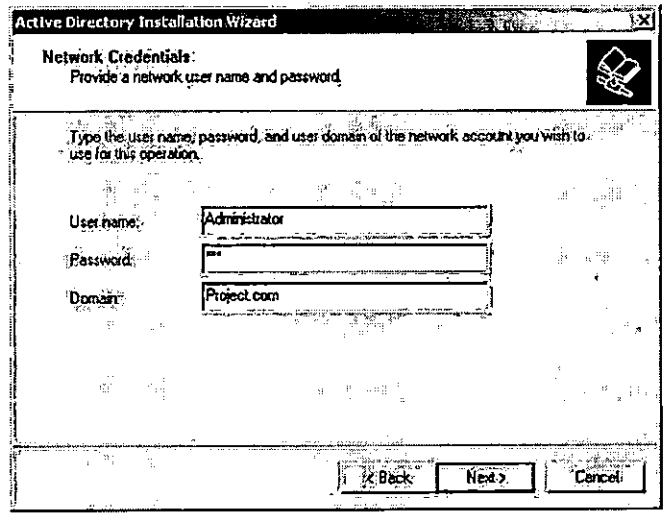


Figure 29. Network Credential Page.

6. The *Additional Domain Controller* page appears as shown in Figure 30. In the *Domain name* box, type the domain name *Project.com*.

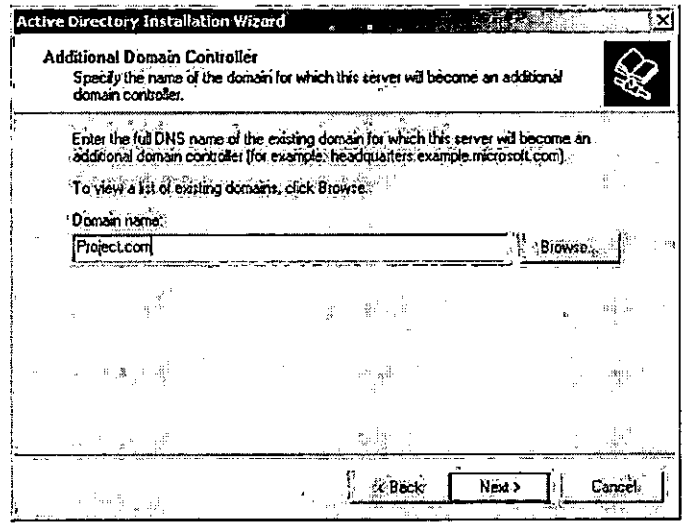


Figure 30. Additional Domain Controller Page.

7. The *Database and Log Locations* page appears. Click *Next* to accept the defaults.
8. The *Shared System Volume* page appears. Click *Next* to accept the default.
9. The *Directory Services Restore Mode Administrator Password* page appears as shown in Figure 31. Type and confirm the password to use when restoring the Active Directory. Record the password in a secure location. Click *Next*.

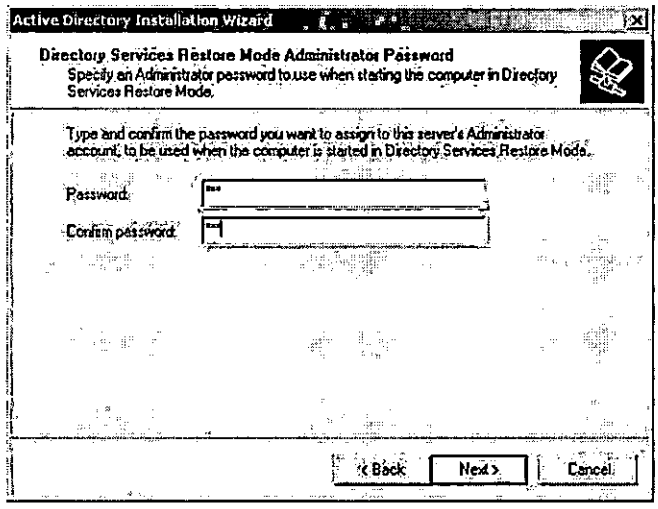


Figure 31. Directory Services Restore Mode Administrator Password Page.

10. The *Summary* page appears. Click *Next.* A Configuring Active Directory status screen appears as shown in Figure 32.

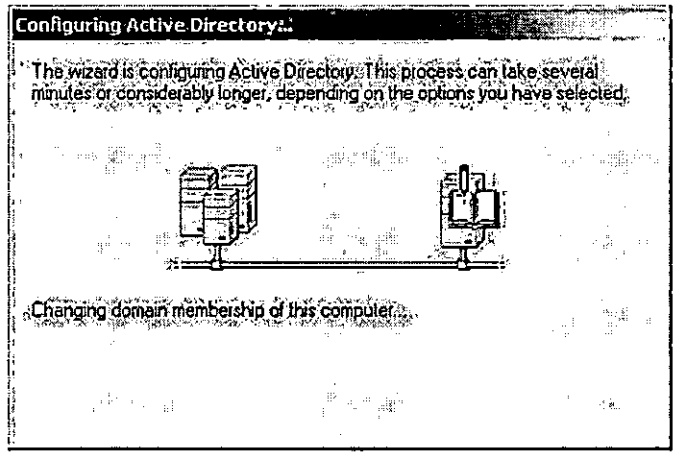


Figure 32. Configuring Active Directory Status Screen.

11. When the *Completing the Active Directory Installation* Wizard page appears, Click *Finish.*

12. A message should appear indicating that the computer needs restarted.

13. Click the *Restart Now* command to restart the computer.

Verify The Creation of The Second Domain Controller

1. Logon to the domain with the administrator account.
2. Click *Start* > *Programs* > *Administrative Tools* > *Active Directory Users and Computers.*
3. In the *Active Directory Users and Computers* window, the domain Project.com is displayed in the console tree. Expand the domain.
4. Click on *Domain Controllers*. Two domain controllers for Project.com are displayed as shown in Figure 33.

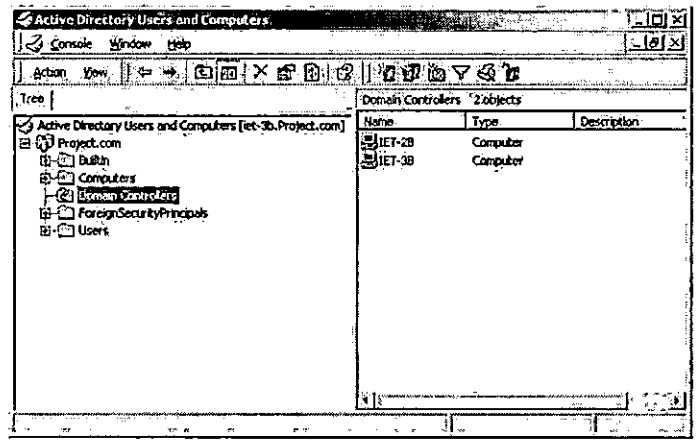


Figure 33. Active Directory Users and Computers Window.

Add Clients into the Existing Domain

In this study, all the computers in the LAN belong to the domain Project.com, and two domain controllers were created, then client computers need added to the domain using the following procedures.

Manually Configure The IP Addressing

1. Log on to a client computer in the LAN as administrator.

2. Right click on *My Network Places* icon and select *Properties* from the menu. The *Network and Dial-Up connections* window appears.
3. Right click on *Local Area Connection* icon in the window. The *Local Area Connection Properties* window appears.
4. In the box named Components checked are used by this connection, highlight *Internet Protocol (TCP/IP)*, and then click on *Properties* button.
5. The *Internet Protocol (TCP/IP) Properties* window opens.
6. In the *IP Address* box, type in: *192.168.0.6*. For each client computer added to the LAN, assign a unique number for the last octet in the IP address. In the *Subnet mask* box, verify that *255.255.255.0* appears. In the *Default gateway* box, type in: *192.168.0.8*.
7. Click on the *Use The Following DNS Server Addresses* radio button. In the *Preferred DNS Server* box, type in: *192.16.0.8*. Click *OK*.
8. The *Internet Protocol (TCP/IP) Properties* window appears as shown in Figure 34. However, the last octet in the IP address box will be different with each client computer added.

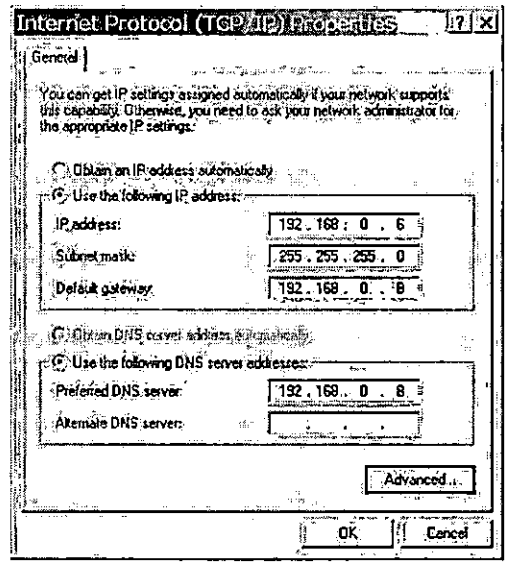


Figure 34. Internet Protocol (TCP/IP) Properties Window.

Add The Computer to The Project.com Domain

1. Right click on *My Computer* icon and select *Properties* from the menu.
2. In the *System Properties* window, click the *Network Identification* tab.
3. Click the *Properties* tab. The *Identification Changes* window appears.
4. In the *Identification Changes* window, click on the *Domain* radio button and type in the domain name: *Project.com* as shown in Figure 35. Click *OK*.
5. The *Domain Username And Password* window appears. Enter the administrator account and password, and Click *OK*.

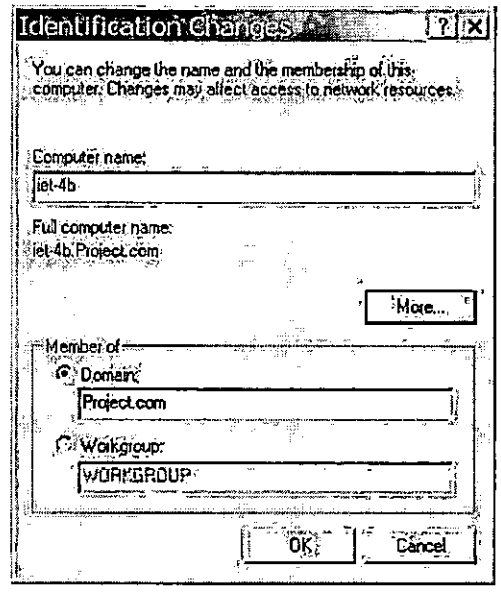


Figure 35. Identification Changes Window.

6. The *Network Identification* window appears again indicating that this computer is now in the domain Project.com.
7. A message appears: *Welcome to the Project.com domain.*
8. Restart the computer as required.

Verify The Creation

1. Logon to the domain controller as administrator.
2. Click *Start* > *Programs* > *Administrative Tools* > *Active Directory Users and Computers*.
3. The *Active Directory Users and Computers* window appears. Expand the domain in the console tree.
4. Click the folder named Computers. The client computer IET-4B is displayed in the right pane as shown in Figure 36.

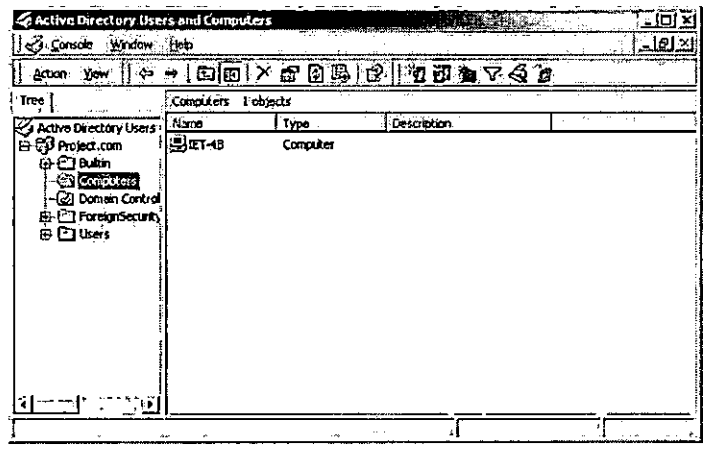


Figure 36. Active Directory Users and Computers.

5. Click on *My Network Places* icon. The *My Network Places* window appears as shown in Figure 37.

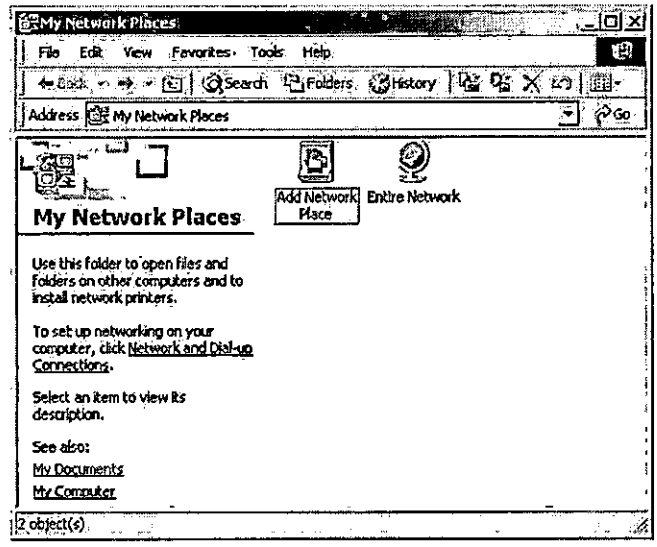


Figure 37. My Network Places Window.

6. Click on *Entire Network* icon. Click *You may also view the entire content of the network.* The *Entire Network* window appears as shown in Figure 38.

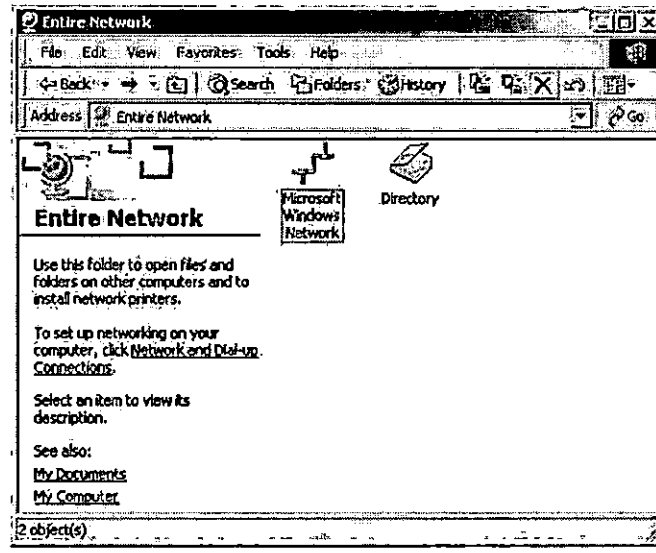


Figure 38. Entire Network Window.

7. Click on *Microsoft Windows Network* icon.

8. Click on the *Project domain* icon. The computers in the domain are displayed as shown in Figure 39.

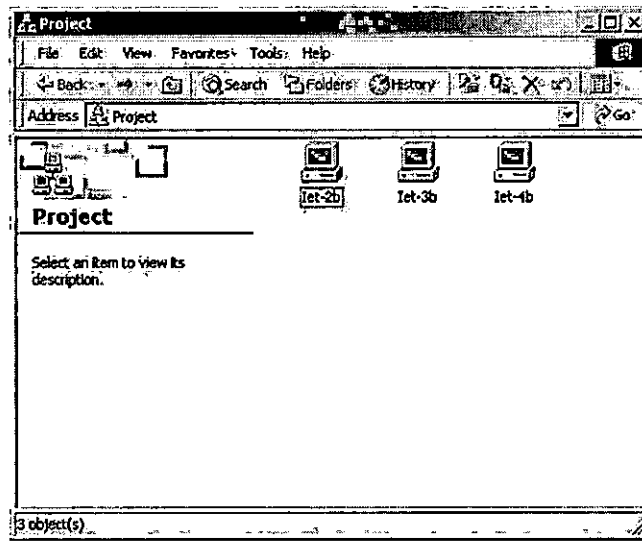


Figure 39. Project Domain Window.

9. The Project domain should now contain three computers, two domain controllers (IET-2B, IET-3B) and one client computer (IET-4B).

In this study, three more client computers were added to the Project.com domain using the previous procedures.

Integrate Designing and Analyzing Tools into The Project.com Domain

With the Project.com domain established and configured, the Mastercam and ANSYS software packages need to be integrated into the domain to realize the purpose. The proposed integration is shown in Figure 40.

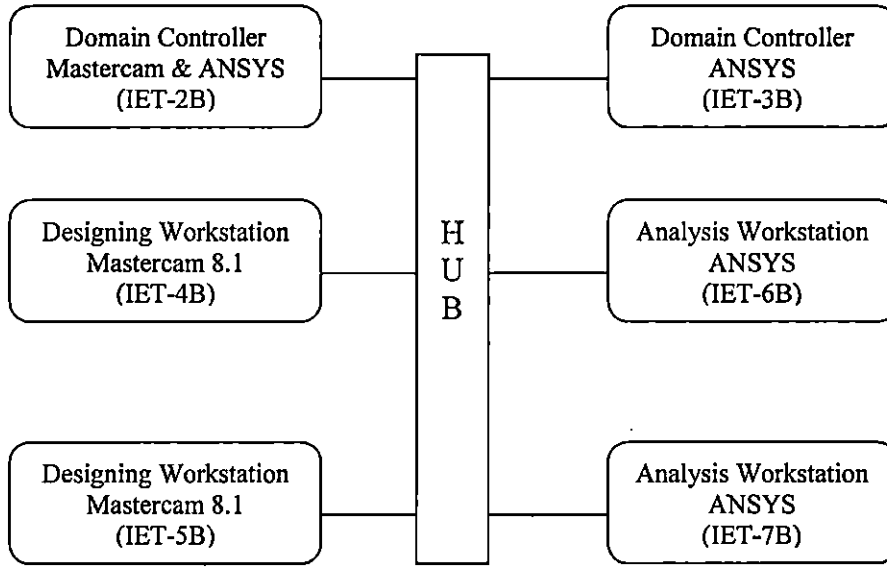


Figure 40. Integration of Mastercam & ANSYS into the Project.com Domain.

Both software packages, Mastercam and ANSYS, were installed on the first domain controller (IET-2B). ANSYS was installed on the second domain controller (IET-3B). IET-3B is now the designated backup controller and an ANSYS

workstation. Mastercam was installed on IET-4B and IET-5B creating two designing stations. ANSYS was installed on IET-6B and IET-7B creating two more analysis workstations. The following procedures were used for the installation.

Mastercam8.1 Installation Procedure

1. Start computer, logon to the domain controller IET-2B as administrator.
2. Insert Mastercam 8.1 CD into the CD-ROM.
3. The setup program runs automatically. The *Mastercam Version8.1* Setup wizard appears as shown in Figure 41. Click *Next*.

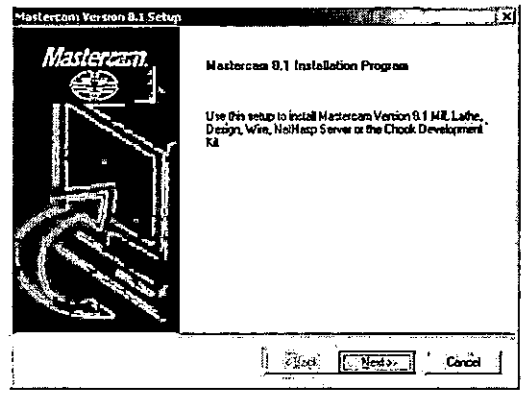


Figure 41. Mastercam Version 8.1 Setup Wizard.

4. The wizard requires selecting one product to install as shown in Figure 42. Select *Install Mastercam*.

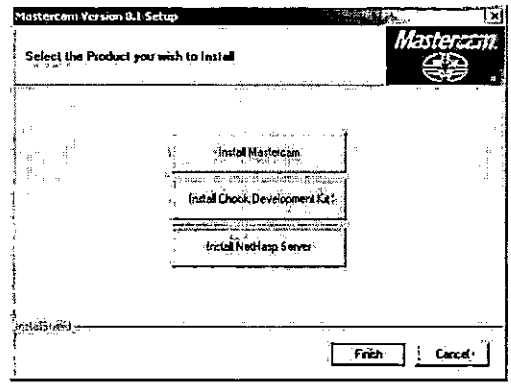


Figure 42. Mastercam Version 8.1 Setup Wizard.

5. The *Mastercam Setup* Wizard appears as shown in Figure 43. Click *Next*.

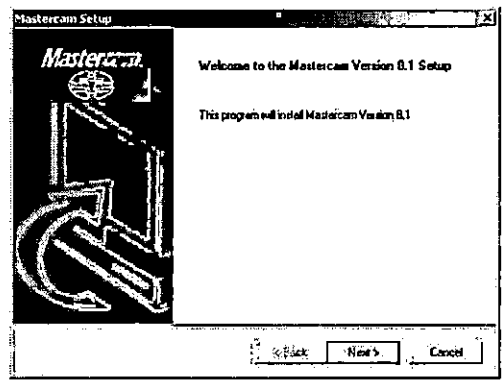


Figure 43. Mastercam Setup.

6. The *License Agreement* page appears, click *Yes* to agree.

7. The *Select Options* page appears as shown in Figure 44. Select *English (Inch)*, and then click *Next*.

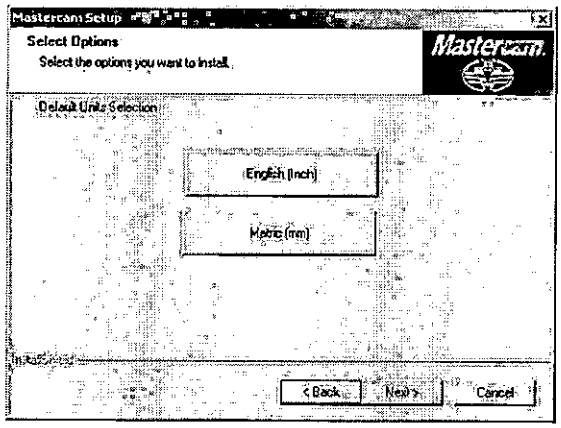


Figure 44. Select Options Page.

8. *Choose Destination Location* page appears as shown in Figure 45. The default destination directory is *C:\Mcam8*. Accept the default by clicking *Next*.

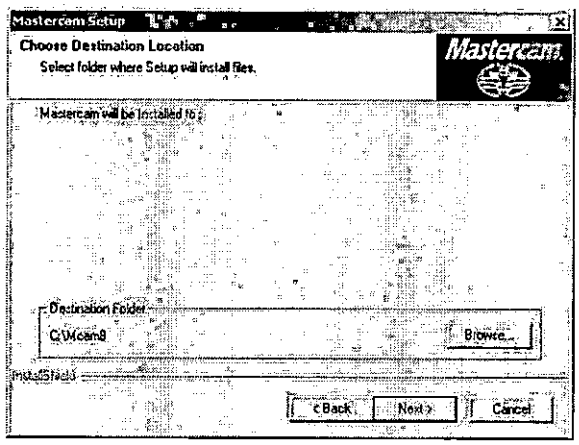


Figure 45. Choose Destination Location Page.

9. *Program Selection* page appears as shown in Figure 46. Make appropriate program selections from the available product. Then click *Next*.

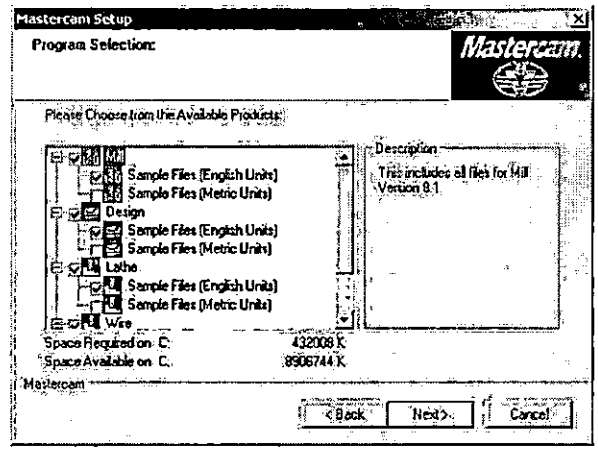


Figure 46. Program Selection Page.

10. *Select Program Folder* page appears as shown in Figure 47. Select folder *Mastercam8* as the program folder in C: drive. Click *Next*.

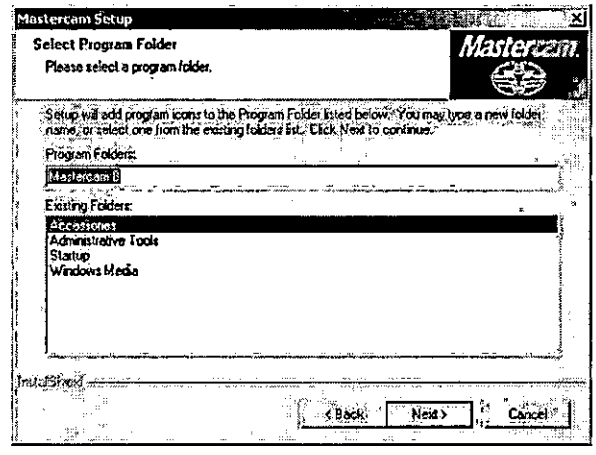


Figure 47. Select Program Folder.

11. Setup now copies Mastercam system files as shown in Figure 48.

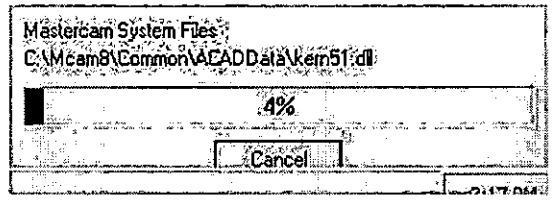


Figure 48. Mastercam Setup Status Screen.

12. When the operation is complete, *File Association Selection* page appears. Select the file types that will be used in the future.
13. When the finish page appears, the Mastercam installation is complete.
14. Repeat the procedure above on computer IET-4B and computer IET-5B.

ANSYS5.7 Installation Procedure

1. Logon to the domain controller IET-2B as administrator.
2. Insert ANSYS 5.7 CD into the CD-ROM.
3. The ANSYS Setup runs automatically.
4. The Setup wizard displays the minimum hardware requirements for ANSYS 5.7 installation as shown in Figure 49.

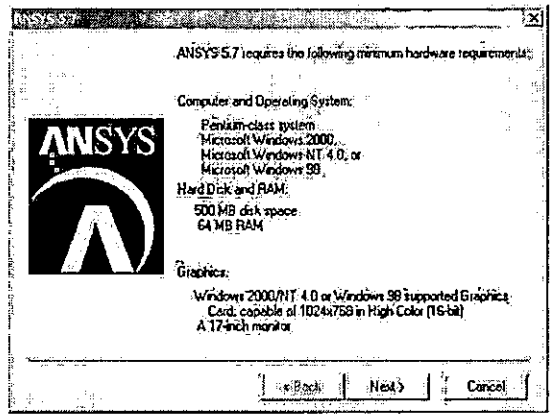


Figure 49. ANSYS 5.7 Setup Wizard.

5. The *ANSYS Installation Type* page appears as shown in Figure 50. Choose *ANSYS products and license server* to install, click *Next*.

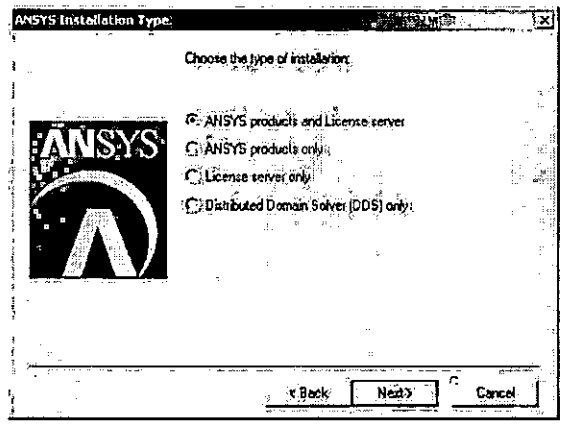


Figure 50. ANSYS Installation Type.

6. The *ANSYS Installation Option* page appears as shown in Figure 51. Select *Typical installation.* Click *Next.*

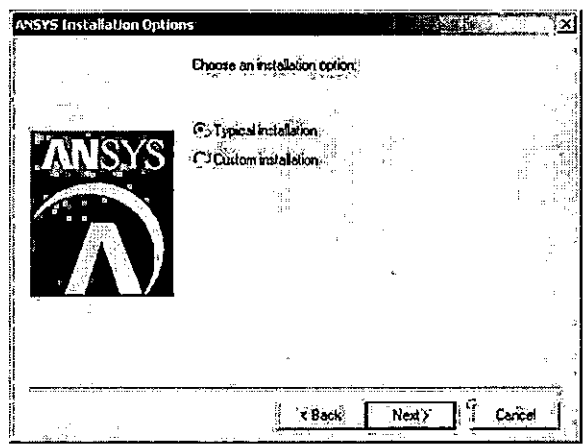


Figure 51. ANSYS Installation Options Page.

7. *Choose Destination Location* page appears as shown in Figure 52. The default destination folder to install ANSYS is: *C:\Program Files\Ansys inc\ANSYS5.7.* Click *Next* to accept the default.

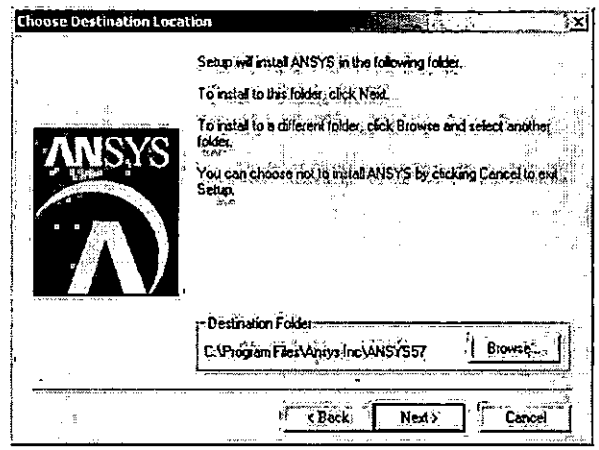


Figure 52. Choose Destination Location Page.

8. The *Select Program Folder* page appears as shown in Figure 53. By default, Setup will add program icons to the program folder named ANSYS 5.7. Click *Next* to accept the default.

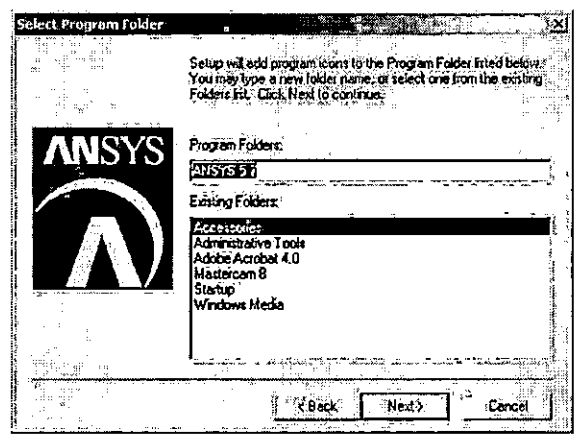


Figure 53. Select Program Folder Page.

9. The *Start Copying Files* page appears as shown in Figure 54 and lists selected settings. Click *Next* to accept.

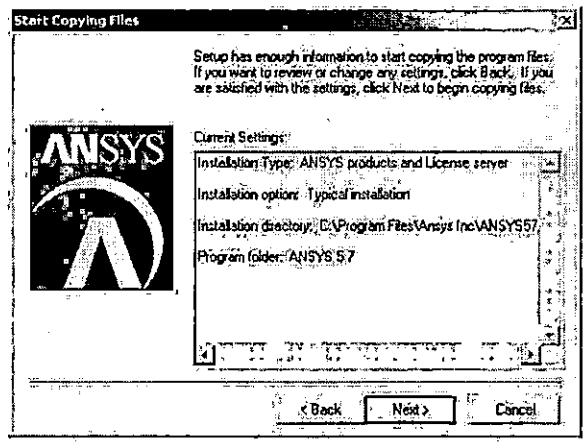


Figure 54. Start Copying Files Page.

10. When files are copied, *Setup Complete* page appears as shown in Figure 55. Click *Finish* to complete setup.

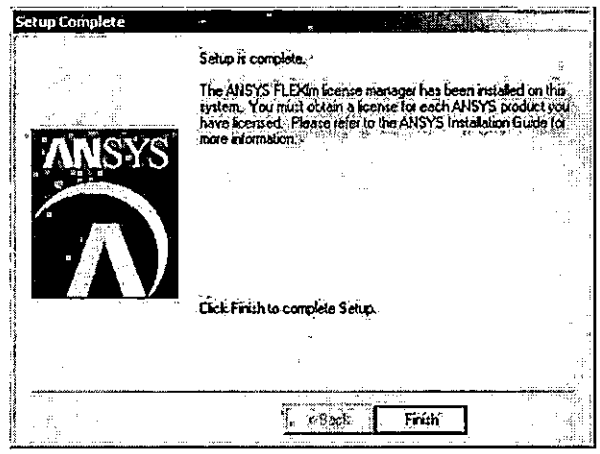


Figure 55. Setup Complete Page.

11. Repeat the procedure on computers IET-3B, IET-6B, and IET-7B.

Initialize Microsoft Management Console (MMC)

MMC is a common console framework for management applications. The MMC provide a common environment for snap-ins, the tools that support the actual management functionality. The MMC environment provides seamless integration

among the various snap-ins, even those provided by different vendors. The MMC allows most administrative tasks to be performed using only one interface, instead of numerous interfaces. Also, MMC consoles can be used to perform the majority of administrative tasks from one computer.

There are two types of MMCs: preconfigured MMCs and customized MMCs. The preconfigured MMCs are installed during the Windows 2000 server installation. Each preconfigured MMC console has only one snap-in and no modifications are allowed. In the domain controller of the Project.com domain, the following preconfigured MMC consoles are installed.

1. Active Directory Domains and Trusts
2. Active Directory Sites and Services
3. Active Directory Users and Computers
4. Component Services
5. Configure Your Server
6. Data Sources
7. Distributed File System
8. Domain Controller Security Policy
9. Domain Security Policy
10. Event Viewer
11. Internet Services Manager
12. Licensing
13. Local Security Policy

14. Performance

15. Routing and Remote Access

16. Server Extensions Administrator

17. Services

18. Telnet Server Administrator

These preconfigured tools can be reached by going to *Start* > *Programs* > *Administrative Tools*. A different window must be opened for each tool. However, the administrator can create a customized MMC console for more efficient usage.

Customized MMC consoles can be created by combining one or more snap-ins or parts of snap-ins. These consoles can be used to centralize and combine administrative tasks, such as: saving the customized MMC to use again; distributing to and sharing the customized MMC with other administrators; and using the customized MMC from any computer to centralize and unify administrative tasks. For the future efficiency and convenience of administrating the Project.com domain, a customized MMC console named MMC01 was created on the domain controller IET-2B, using the following procedure.

1. Logon to Project.com domain as administrator. Click *Start* > *Run*.
2. In the *Open* box, type *mmc* and click *OK*. An empty MMC console window opens.
3. Maximize the console window. Maximize the Console Root window.
4. On the *Console* menu, click *Add/Remove Snap-in*.
5. Click the *Add* command button.

6. The available standalone snap-ins which can be added to a customized MMC are displayed in the *Add Standalone Snap-in* window as shown in Figure 56. Find and highlight the *Active Directory Domains and Trusts* snap-in.

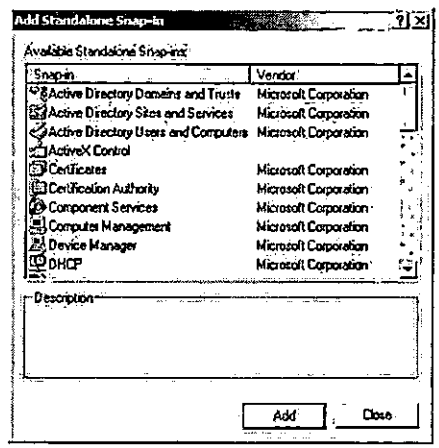


Figure 56. Add Standalone Snap-in Window.

7. Click the *Add* button.
8. In the *Add Standalone Snap-in* dialog box, click *Close*.
9. In the *Add/Remove Snap-in* dialog box, click *OK*.

Repeat the procedure to add three more snap-ins in the console: Active Directory Sites and Services, Active Directory Users and Computers, and Computer Management.

10. The customized MMC console with the four snap-ins added is shown in Figure 57. More snap-ins can be added as needed.

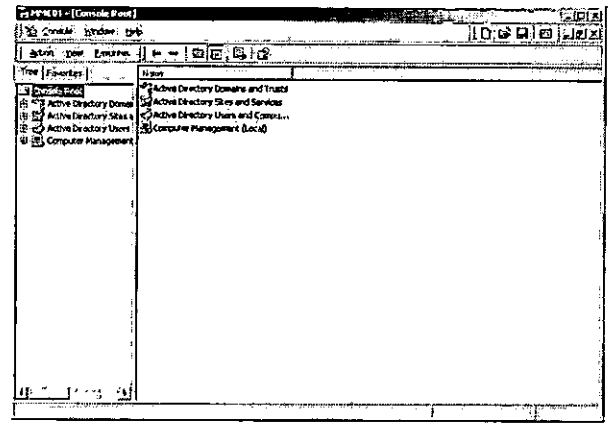


Figure 57. MMC01.

11. On the *Console* menu, click *Save As*. In the File name box, type *MMC01*.

Click the *Save* command button.

The customized MMC console MMC01 is now saved under the Administrative Tools with the file name MMC01.msc.

Create and Configure User Accounts

The following eight user accounts were created in the Project.com domain for this study.

Administrator:	An account for domain administrator. Responsibilities are network maintenance and trouble-shooting.
Admin-iet:	An account for department manager. Responsibilities are managing the product designing and analysis process, making important decisions, and managing the product information database.

Analyzer01-iet: An account for the team leader of analyzers. Responsibilities are managing the product analysis process, making decisions in the team, and managing part of the product information database.

Analyzer02-iet & Analyzer03-iet: Accounts for team members of analyzers. Responsibilities are analyzing product performance in real environment by using ANSYS, saving analysis results into product information database, and assisting the team leader in decision making.

Designer01-iet: An account for the team leader of designers. Responsibilities are managing the product designing process, making decisions in the team, and managing part of the product information database.

Designer02-iet & Designer03-iet: Accounts for team members of designers. Responsibilities are designing product model by using Mastercam, saving product models into product information database, and assisting the team leader in decision making.

The Administrator account must be created while installing the Windows 2000 server. The other accounts were created under the Project.com domain. For the

efficiency of administration, all the user accounts were created in one OU (Organizational Unit) in the domain using the following procedure.

Create an OU in MMC Console

1. Logon to the domain as administrator. Activate MMC01 console.
2. Under Active Directory Users and Computers, expand the Project.com domain.
3. Right click on the *Project.com* domain in the console tree and click *New > Organizational Unit.*
4. In the *Name* box, type *Users-iet* and click *OK.*
5. The MMC01 console in which the OU named User-iet is created for user accounts in the Project.com domain is shown in Figure 58.

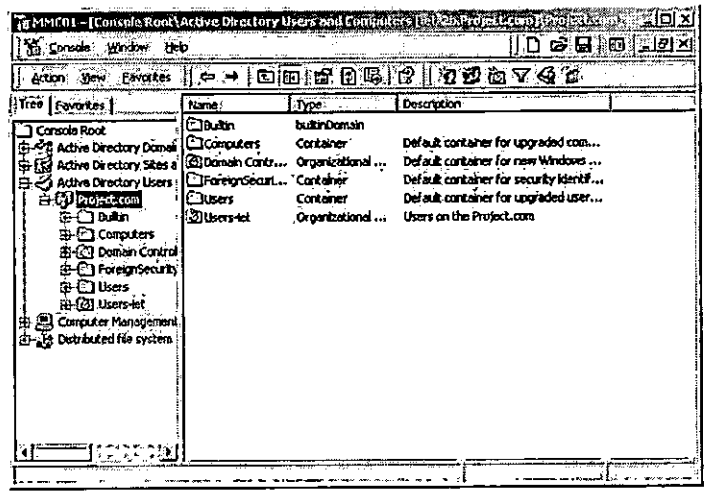


Figure 58. MMC01 Console.

Create User Account for Admin-iet

1. Right click on the *Users-iet* organization unit and click *New > User.*
2. The *New Object-User* dialog box appears as shown in Figure 59.

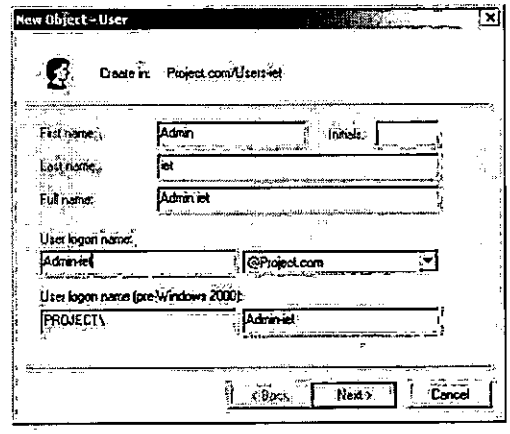


Figure.59 New Object-User Dialog Box.

3. Create a user account by filling in the following information as shown in Figure 59.

   First name = Admin, Last name = iet

4. The system fills in the *Full name* box, using information from the First name and Last name boxes. The Full name is Admin iet.
5. In the *User Logon name* box, type *Admin-iet.*
6. In the unnamed box next to the *User Logon name* box, make sure the Project.com domain name is displayed as *@Project.com.*
7. Click *Next* to access the New Object-User dialog box with password options as shown in Figure 60.

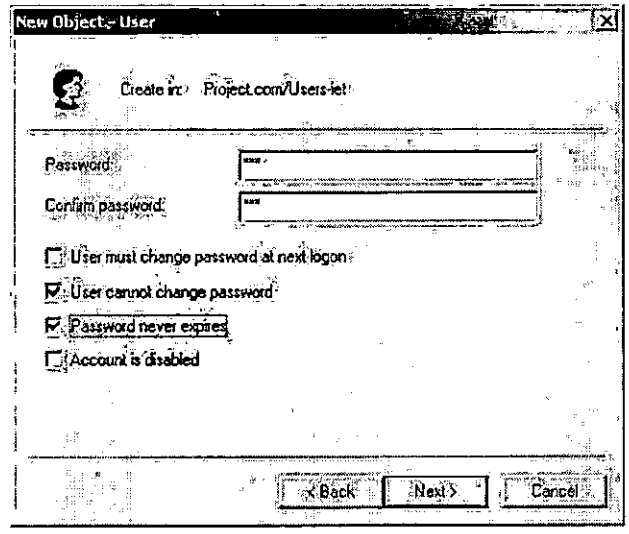


Figure 60. New Object-User Dialog Box.

8. Type in password and select any options as need.
9. Click *Next*. A dialog box displays the users attributes that have been set.
10. Click *Finish* to finish creating the Admin-iet account.

Modify Properties for Admin-iet Account

Since Admin-iet is an account for the department manager, it was added to the group of domain administrator using the following procedure.

1. In the console tree of MMC01, expand the Project.com domain. Click *User-iet* ou to open it.
2. Double click on *Admin-iet* account to open the properties dialog box. Click the *Member of* tab, the users account is already in the domain user group by default, as shown in Figure 61, the Admin-iet Properties dialog box.

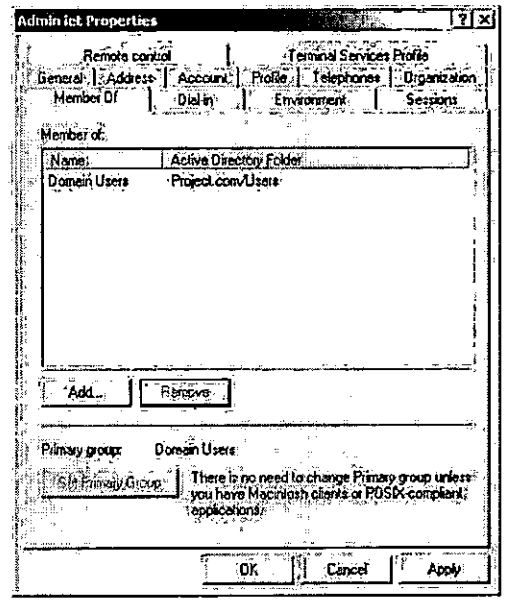


Figure 61. Admin-iet Properties Dialog Box.

3. Click the *Add* button to open the *Select Groups dialog box* as shown in Figure 62.

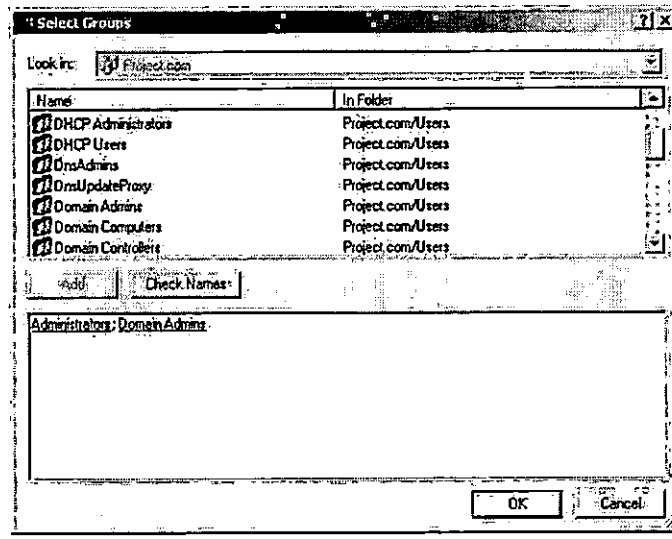


Figure 62. Select Groups Dialog Box.

4. Select the *Administrator* group and the *Domain Admins* group from the upper box by double clicking on them. The two group names are then displayed in the lower box as shown in Figure 62. Click *OK* to go back to the Admin-iet Properties dialog box.
5. Three group names are now displayed under the *Member of* tab as shown in Figure 63. The Admin-iet account is now a member of these groups: *Domain Users, Domain Admins, and Administrators.*

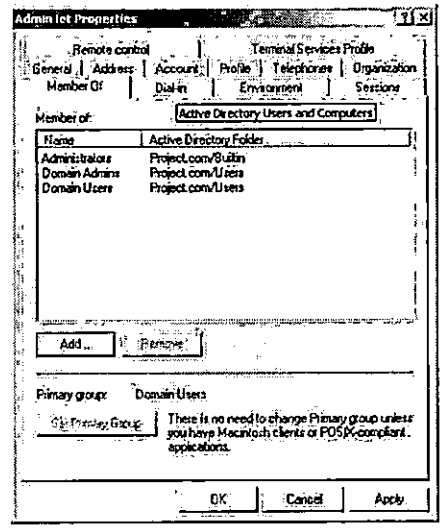


Figure 63. Admin-iet Properties Dialog Box.

Create Other User Accounts

According to the steps above, the other user accounts were created, and their memberships configuration and their logon restrictions were set as shown in Table 1.

Table 1.
User Accounts Properties

User Name	Description	Member of	Can Logon to...
Administrator	Domain Admin	Domain Admins Domain Users	All computers in the domain
Admin-iet	Department Manager	Domain Admins Administrators	All computers in the domain
Designer01-iet	Team Leader	Domain Users	IET-2B, IET-3B, IET-4B, IET-5B
Designer02-iet	Team member	Domain Users	IET-4B, IET-5B
Designer03-iet	Team member	Domain Users	IET-4B, IET-5B
Analyzer01-iet	Team Leader	Domain Users	IET-2B, IET-3B, IET-6B, IET-7B
Analyzer02-iet	Team member	Domain Users	IET-6B, IET-7B
Analyzer03-iet	Team member	Domain Users	IET-6B, IET-7B

Because Designer01 and Analyzer01 were team leaders for their teams, they were granted the permissions to logon at domain controllers, but were not granted the rights of administrators. Following are the procedures to allow users to logon at domain controllers and to restrict a user's logon to a specific computer.

To allow users to logon at domain controllers.

1. Logon to the Project.com domain as Administrator.
2. Click *Start* > *Programs* > *Administrative Tools* > *Domain Controller Security Policy*.
3. The *Domain Controller Security Policy* preconfigured snap-in appears.
4. In the console tree, expand *Security Settings*.
5. Expand *Local Policies*.
6. Select *User Rights Assignment*, as shown in Figure 64.

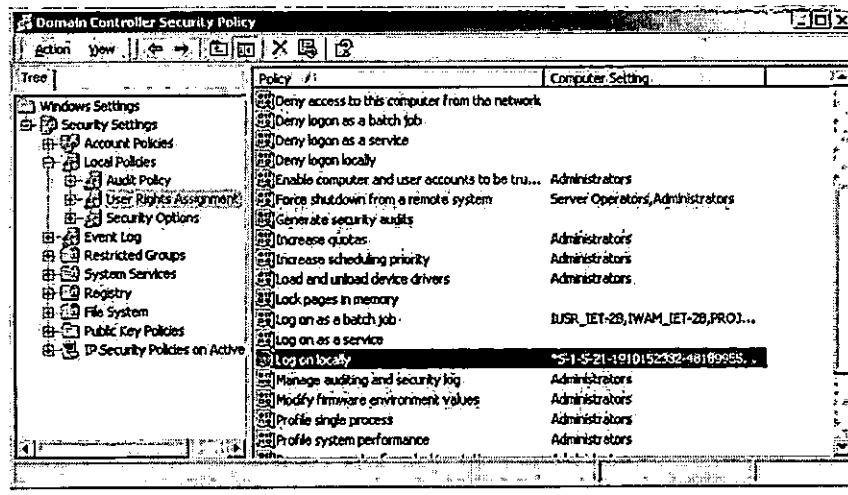


Figure 64. Domain Controller Security Policy Snap-in.

7. In the right detail pane, double click *Log on locally* as shown in the Figure 64.
8. Click the *Add* command button to access the *Add User or Group* dialog box.
9. Click the *Browse* command button and highlight *Authenticated Users*.
10. Click the *Add* command button, and then click *OK*.
11. In the *Add User or Group* dialog box, click *OK*.
12. Authenticated Users now appears in the list of groups with the right to log on locally.
13. Click *OK* to return to the *Domain Controller Security Policy* window.
14. Exit *Domain Controller Security Policy*.

To restrict Designer02-iet logon to specific computers.

1. Logon to the Project.com domain as Administrator.
2. Open the *MMC01* console and expand the *Project.com* domain.

3. Select the *Designer02-iet* account, double click it to open the *Properties* dialog window.
4. In *Designer02 Properties* dialog box select the *Account* tab.
5. Click the *Log On To* command button.
6. In the *Logon Workstations* dialog box, select *The user can log on to: The following computers* item by double clicking it.
7. In the *Computer name* box, type in *IET-4B*, click *Add* button.
8. Again in the *Computer name* box, type in IET-5B, click *Add* button.
9. As shown in Figure 65, user Designer02-iet is restricted to logon to workstations IET-4B and IET-5B.

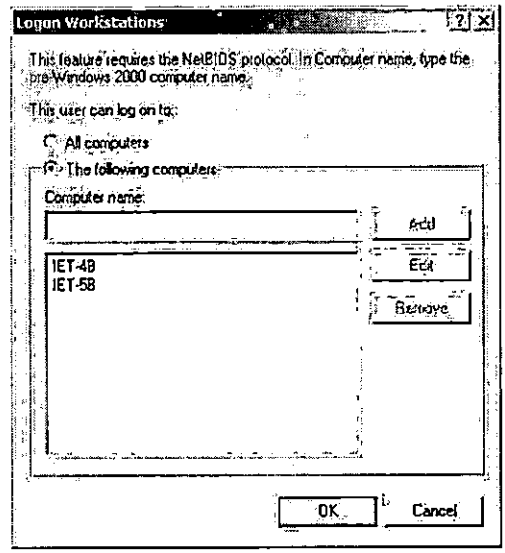


Figure 65. Logon Workstation Dialog Box.

10. Click *OK* to return to the *Properties* dialog box.
11. Click *OK* to return to the *MMC01 console*.
12. Exit from MMC01 console.

Administer Roaming Profiles for Users

A user profile is a collection of folders and data that stores the user's current desktop environment and application settings. It also records all network connections that are established when a user logs on to a computer, such as mapped drivers to shared folders on a network server. A roaming user profile is created and stored on a server and is available every time the user logs on any computer on the network. So, on the domain controller IET-2B of the Project.com domain, roaming user profiles were created for Designer01, Designer02, Designer03, Analyzer01, Analyzer02, and Analyzer03 using the following procedure.

1. Logon to the Project.com domain from the domain controller IET-2B as Administrator account.
2. Activate *Windows Explorer* and highlight C:.
3. Create a *Profiles* folder under C:, and share it on the network. Then exit *Windows Explorer*.
4. Activate the *MMC01* console.
5. Under *Active Directory Users and Computers*, expand *Project.com* domain.
6. Select the *User-iet* organizational unit.
7. Double-click the *Analyzer01-iet* account to access the user's *Properties* dialog box.
8. Select the *Profile* tab.

9. In the *Profile Path* box, type \\IET-2B\Profiles\%Analyzer01% as shown in Figure 66.

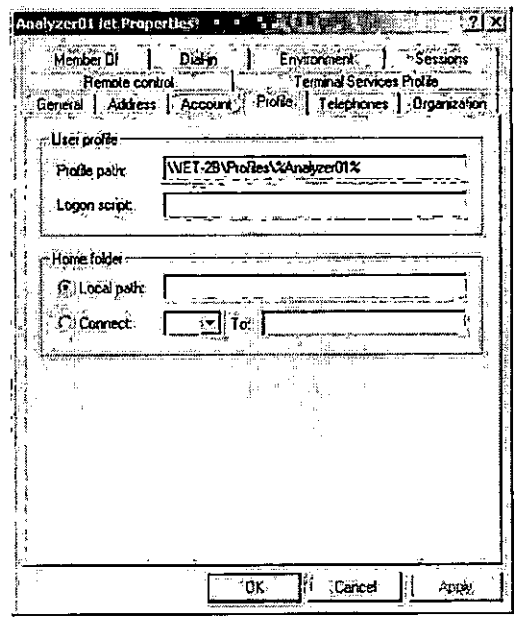


Figure 66. Analyzer01-iet Properties Dialog Box.

10. Click *OK* to return to the *MMC01 console*.
11. Exit the *MMC01 console*.
12. Log off the domain controller.
13. Logon to the domain as Analyzer01.
14. Change the screen color and log off.
15. Logon to the domain as Administrator account.
16. Activate *Control Panel* and double click *System* icon.
17. In the *System Properties* dialog box, click the *User Profiles* tab.
18. As shown in Figure 67, the profile stored for Analyzer01 is a roaming user profile.

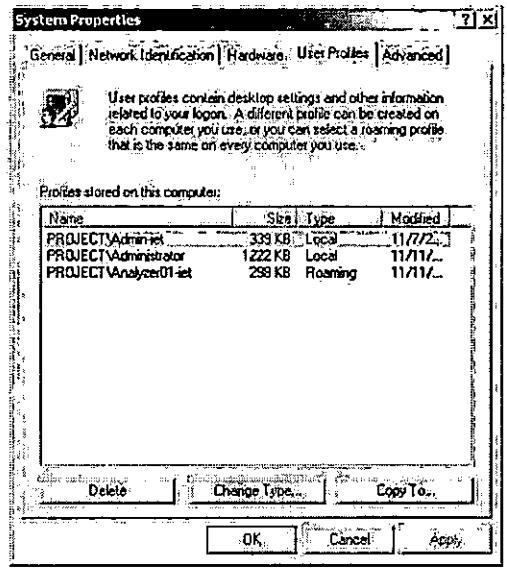


Figure 67. System Properties Dialog Box.

Following the steps above, roaming user profiles were created for the other five users.

Implement Distributed File Systems

In this study, a Distributed File System was implemented in the Project.com domain to manage the product information as well as realize fault tolerance and backup. The Distributed File System (Dfs) is a single, logical, hierarchical file system that organizes shared folders on different computers in a network to provide a logical tree structure for file system resources. Because the Dfs tree is a single point of reference, regardless of the actual location of the underlying resources, users can easily gain access to network resources.

Dfs simplifies network administration. If a server fails, a Dfs link can be moved from one server to another without users being aware of the change. All that is

required to move a Dfs link is to modify the Dfs folder to refer to the new server location of the shared folders. Users continue to use the same Dfs path for the Dfs link.

Dfs system uses a tree structure containing a root and Dfs links. There are two types of Dfs roots: stand-alone Dfs roots and domain Dfs roots/fault tolerant Dfs roots.

Stand-alone Dfs information is stored in the local links, permitting a single level of Dfs links. Stand-alone Dfs roots can be located on all supported file systems, but they offer no replication or backup. Consequently, the Dfs root represents a single point of failure.

In a domain Dfs root, multiple servers hand out referrals for the Dfs namespace. Fault tolerant Dfs roots use Active Directory services to store Dfs tree topology and remove the root as a single point of failure. A fault tolerant Dfs root is stored in Active Directory services and replicated to every participating Dfs root server. Changes to a Dfs tree are automatically synchronized with Active Directory services. This ensures that a Dfs tree topology can always be restored if the Dfs root is offline for any reason. Fault tolerance at the file and content level can also be implemented by assigning alternate resources to a Dfs volume. Dfs replication topology uses the existing Active Directory replication topology. In order to realize the security and efficiency of product information management, the domain/fault tolerance Dfs root was implemented in the domain controllers of the Project.com domain.

Create Shared Folders on Domain Controllers

For centralized management and security on the network, shared folders were created on the domain controllers. Table 2 contains the description of the shared folders.

Table2.
Shared Folder Information

Shared Name	Location	Description
DESIGN	IET-3B	Container for product models designed by team members
ANALYSIS	IET-3B	Container for ansys results from team members of analyzer
Drafts$	IET-2B	Container for product models approved by team leader
Results$	IET-2B	Container for ansys results approved by team leader
Final-version$	IET-2B	Container for final product models approved by administrators

Since important product information is stored in these folders, the permission to access these folders were assigned with restrictions. The shared folder permissions were assigned using the following procedure.

1. Logon to the Project.com domain as administrator.
2. Activate *Windows Explorer*.
3. Locate and highlight the *shared folder*.

4. Right-click the *shared folder* and select *Properties* from the menu to access the shared folder *Properties* dialog box.

5. Click the *Sharing* tab as shown in Figure 68.

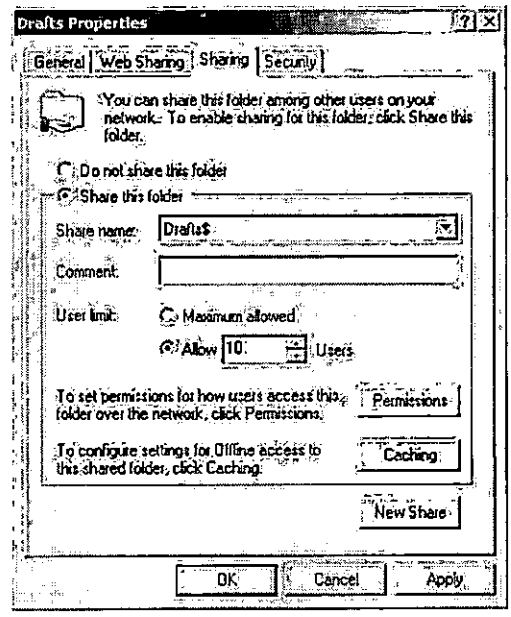


Figure 68. Shared Folder Properties Dialog Box.

6. Click the *Share this folder* radio button.

7. Type in the share name for the folder.

8. Click the *Permissions* button to access the *Permissions for the shared folder* Dialog Box as shown in Figure 69.

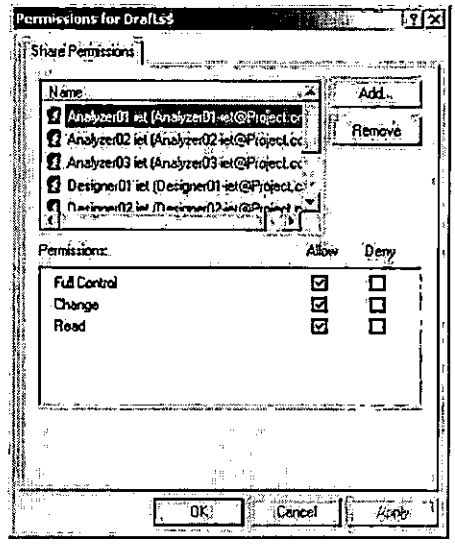


Figure 69. Permissions for Draft$ Dialog Box.

9. Click the *Add* button to access the *Select Users, Computers, or Groups* dialog box as shown in Figure 70.

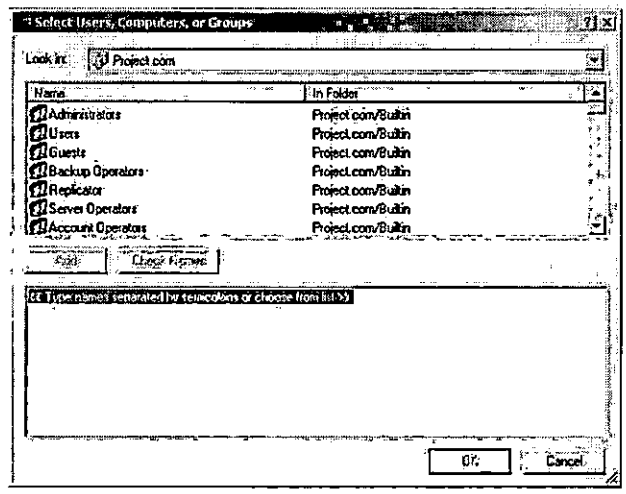


Figure 70. Select Users, Computers, or Groups Dialog Box.

10. Highlight the selected users or groups and click *OK*.

11. In the *Permissions* box, select permissions for selected users or groups.

12. Click *OK* to return to the *Properties* dialog box.

13. Click *OK* to return to the *Windows Explorer* screen.

The access permissions assigned for the shared folders are described in Table 3.

Table 3.
Access Permissions Assigned to Users

	Admin	Designer 01	Designer 02	Designer 03	Analyzer 01	Analyzer 02	Analyzer03
DESIGN	Full	Full	Full	Full			
ANALYSI	Full				Full	Full	Full
Drafts$	Full	Full	Read	Read	Full	Read	Read
Results$	Full	Full	Read	Read	Full	Read	Read
Final-v	Full	Read			Read		

As described in Table 3, the Administrator has full control permissions to all shared folders in the Project.com domain. Team leaders have full control permission to folders that contain product information from/created by team members and also folders that contain product information approved by team leaders. They only have read permissions to the product information that has been approved by administrator groups. Only approved product information can be added to a product model. Team members can always save their information into the database, but they cannot change the original data without the administrator's permission.

Create A Domain Dfs Root in The Project.com

1. Logonto the domain controller IET-2B as administrator.
2. Open the *MMC* console. Click *Distributed File System* in the console tree.

3. Click the *Action* menu, and then click *New Dfs Root*. The *New Dfs Root* wizard appears as shown in Figure 71.

Figure 71. New Dfs Root Wizard.

4. Click *Next*. The *Select The Root Type* screen appears as shown in Figure 72. Select the *Create A Domain Dfs Root* radio button, and then click *Next*.

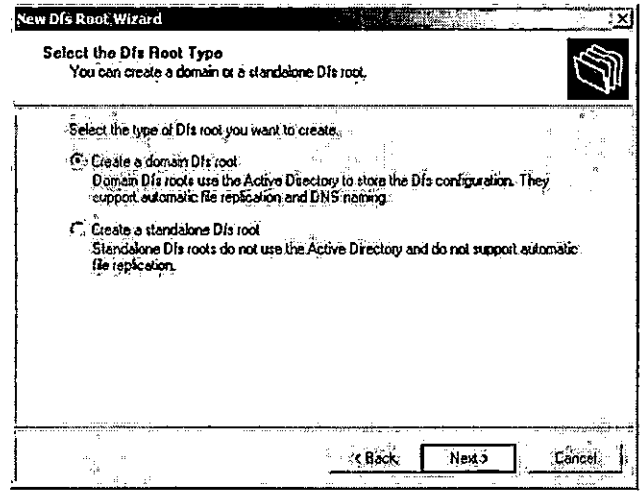


Figure 72. Select the Dfs Root Type Screen.

5. The *Select the host domain for the Dfs root* screen appears as shown in Figure 73. Project.com appears in the *Domain Name* box and in the *Trusting Domains* box.

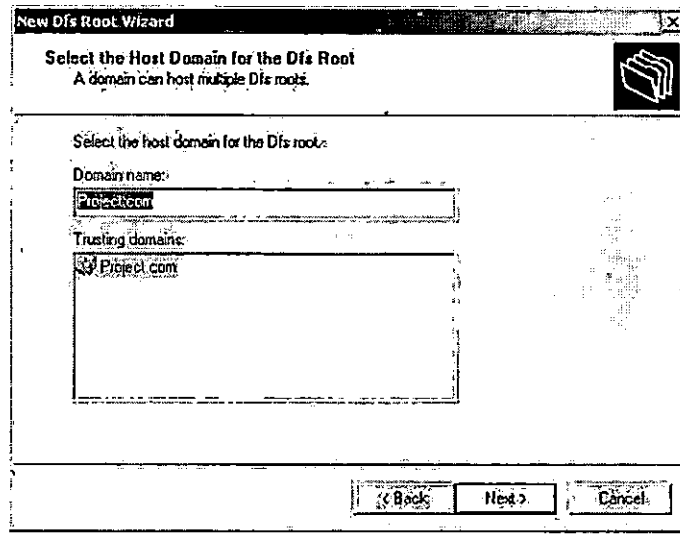


Figure 73. Select the Host Domain for the Dfs Root Screen.

6. Click *Next*. The *Specify the Host Server for the Dfs Root* screen appears as shown in Figure 74. The Domain controller, iet-2b.Project.com, appears in the *Server Name* text box.

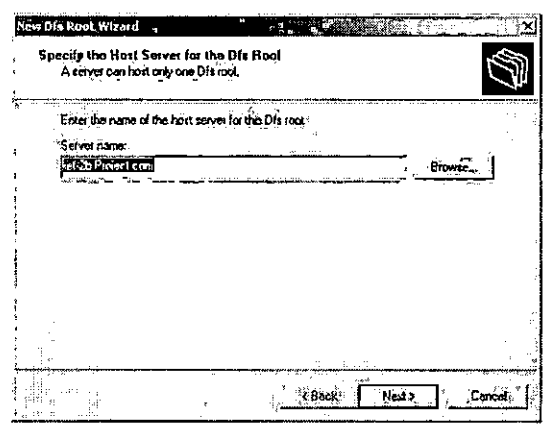


Figure 74. Specify the Host Server for the Dfs Root Screen.

7. Click *Next*. The *Specify the Dfs Root Share* screen appears as shown in Figure 75.

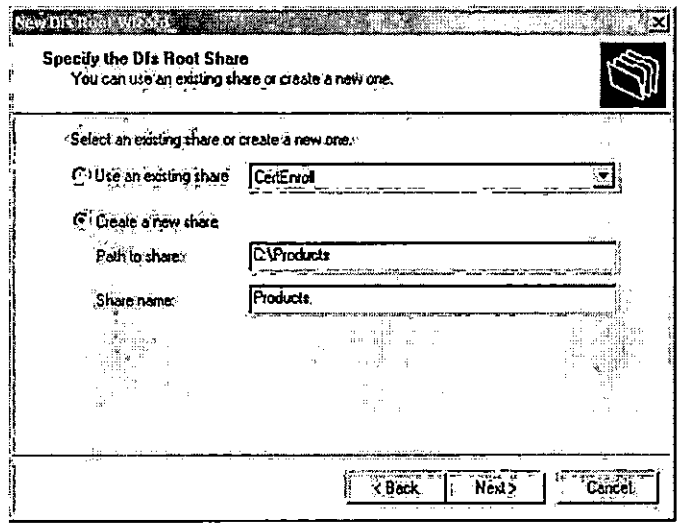


Figure 75. Specify the Dfs Root Share Screen.

8. Select *Create a new share* radio button. Type in the Path to share: *C:\Products*, and type in the Share name: *Products*. Click *Next*.

9. A message window appears, as shown in Figure 76, indicating the new shared folder will be created in the domain controller, iet-2b.Project.com. Select *Yes*.

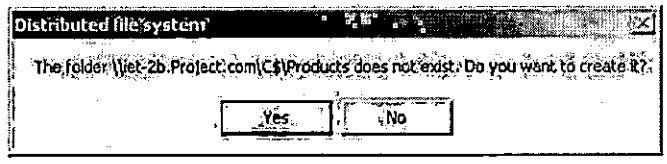


Figure 76. Dfs Message Window.

10. The *Name the Dfs Root* screen appears as shown in Figure 77. Click *Next*.

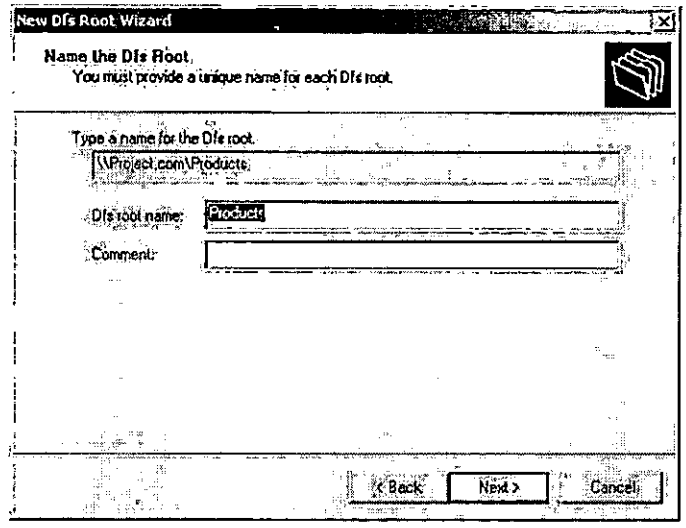


Figure 77. Name the Dfs Root Screen.

11. The *Completing the New Dfs Root Wizard* screen appears. It displays the settings of the new domain Dfs just created.
12. Click *Finish.* The *Distributed File System Manager* snap-in appears, and the Dfs root is configured on iet-2b.Project.com and appears as \\Project.com\Products.

Create a Dfs Root Replica

1. On domain controller IET-2B, open the *MMC01* console and expand the Dfs Manager.
2. Select \\Project.com\Products from the console tree. The \\IET-2B\Products Dfs root appears in the right pane.
3. Click the *Action* menu, and then click *New Root Replica.*

4. The *Specify The Host Server for the Dfs Root* screen appears as shown in Figure 78. In the *Server Name* box, type iet-3b.Project.com and then click *Next.*

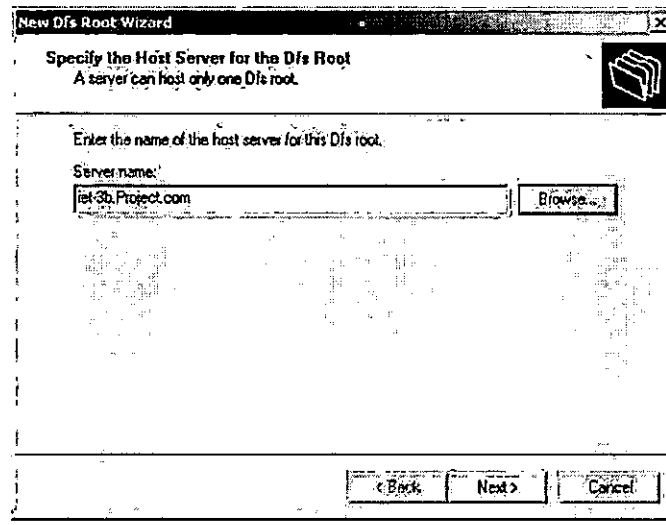


Figure 78. Specify the Host Server for the Dfs Root Screen.

5. The *Specify the Dfs Root Share* screen appears as shown in Figure 79.

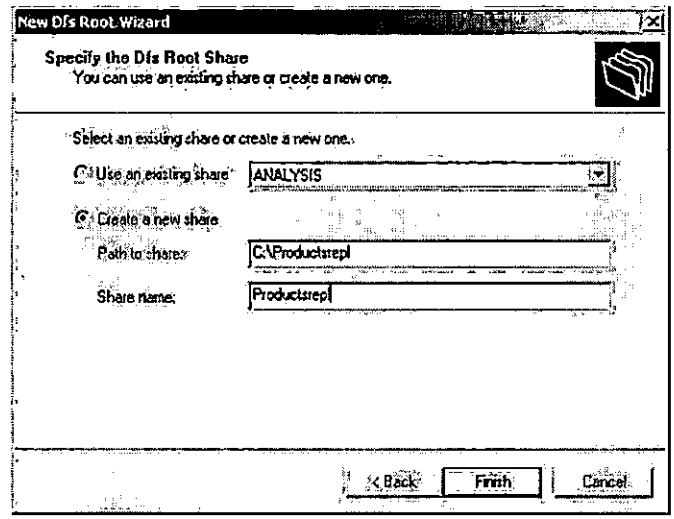


Figure 79. New Dfs Roof Wizard.

6. Select the *Create a new share* radio button. In the *Path to share* box; type *C:\Productsrepl*. In the *Share name* box, type *Productsrepl*. Click *Finish.*
7. The *Distributed File System Message* box appears stating that \\iet-3b\c$\Productsrepl does not exist. Click *Yes* to create the folder.

Establish File Replication System for the Dfs Root Replica

A replication policy is installed so that the Dfs root is automatically synchronized with its replica.

1. On domain controller IET-2B.Project.com, open the *MMC01* console.
2. Select \\Project.com\Products from the console tree. The \\iet-2b\Products Dfs root and the \\iet-3b\Productsrepl appear in the right pane.
3. Click the *Action* menu, and then click *Replication Policy*. The *Replication Policy* dialog box appears.
4. Click \\iet-2b\Products, and then click *Set Master*. Click \\iet-3b\Productsrepl, and then click *Enable to enable replication* as shown in Figure 80.

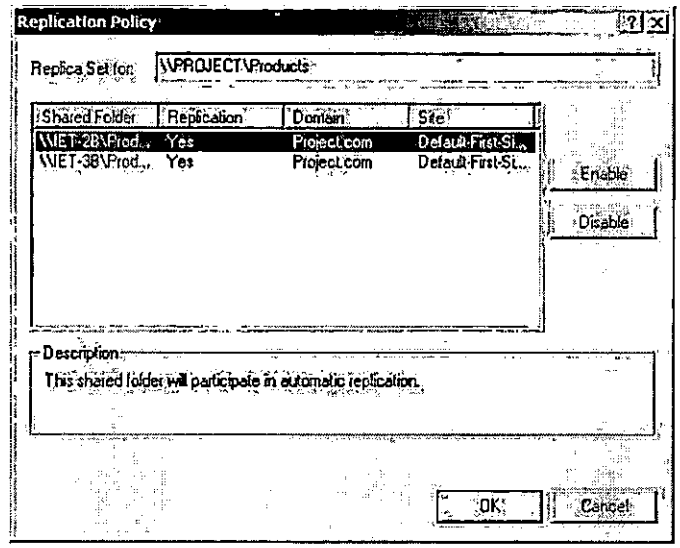


Figure 80. Replication Policy Dialog Box.

5. Click *OK* to close the *Replication Policy* dialog box.

Create Dfs Links

1. On domain controller iet-2b.Project.com, open *the MMC01* console.
2. Select \\Project.com\Products from the console tree.
3. Click the *Action* menu, and then click *New Dfs Link.* The *Create a new Dfs Link* dialog box appears.
4. In the *Link name* box, type *Mastercam.* In the *Send the user to this shared folder* box, type \\iet-3b\DESIGN. In the *Comment* box, type *design drafts from team members* as shown in Figure 81. Click *OK.*

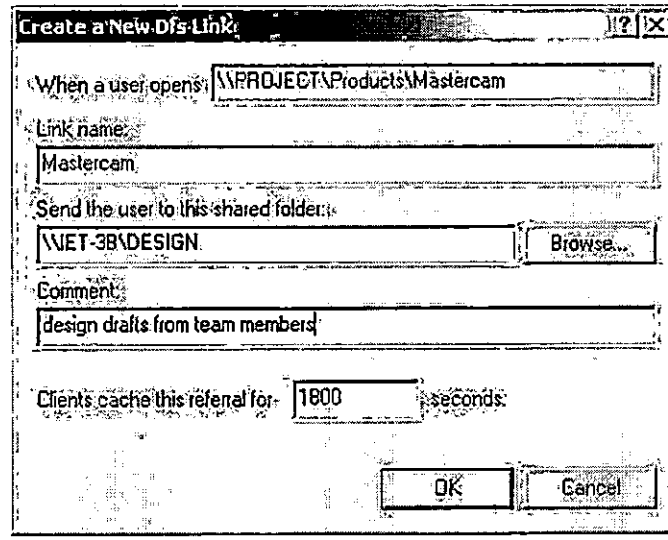


Figure 81. Create a New Dfs Link Dialog Box.

5. Repeat steps 3-4 to create the new Dfs links described in Table 4.

Table 4
New Dfs Links

Link Name	Send the user to the shared folder	Comment
Mastercam	\\iet-3b\DESIGN	Design drafts from team members
Ansys	\\iet-3b\ANALYSIS	Ansys results from team members
Admin-D	\\iet-2b\Drafts$	Drafts approved by team leader
Admin-A	\\iet-2b\Results$	Ansys approved by team leader
Product-new	\\iet-2b\Final-version$	Final product model

Now, the whole distributed file system is created in the Project.com domain. On domain controller IET-2B, open the *MMC01* console and click the *Distributed File System* snap-in. The Project.com\Product Dfs root appears. Expand the Dfs root; all Dfs links in Project.com will be displayed in the console tree and all shared folders corresponding to the links will be displayed in the right pane as shown in Figure 82.

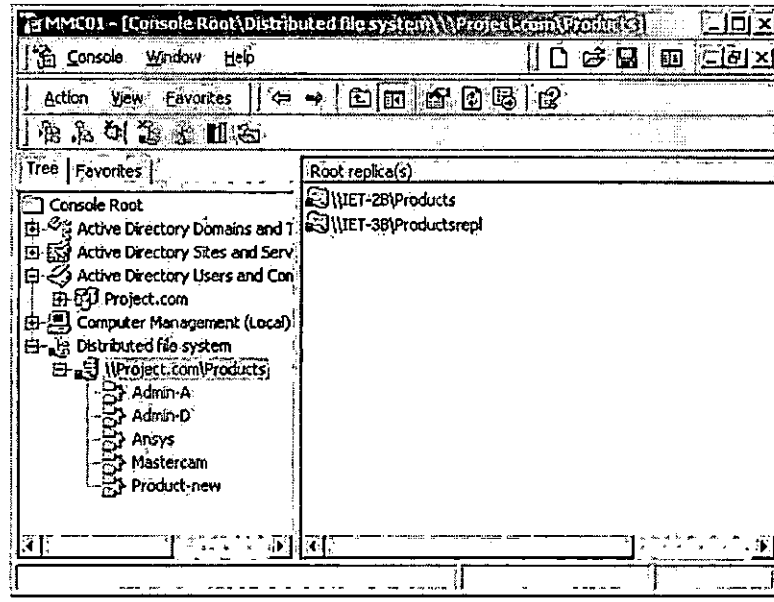


Figure 82. MMC01 cosole.

Users, who logon to the Project.com domain, can access the shared folders with access permissions by indicating only the path to the Dfs root without knowing the exact locations of shared folders. They type the path \\Project\Products in the address box of My Network Places window, then the Dfs links are displayed in the window just as folders created on the same computer.

Simulation of a Product Information Process

In this part of the study, a simple product information process was simulated on the Project.com domain. Then a part model was designed with Mastercam8.1 and analyzed with ANSYS5.7. The Dfs system played an important role in managing the product information flow as shown in Figure 83.

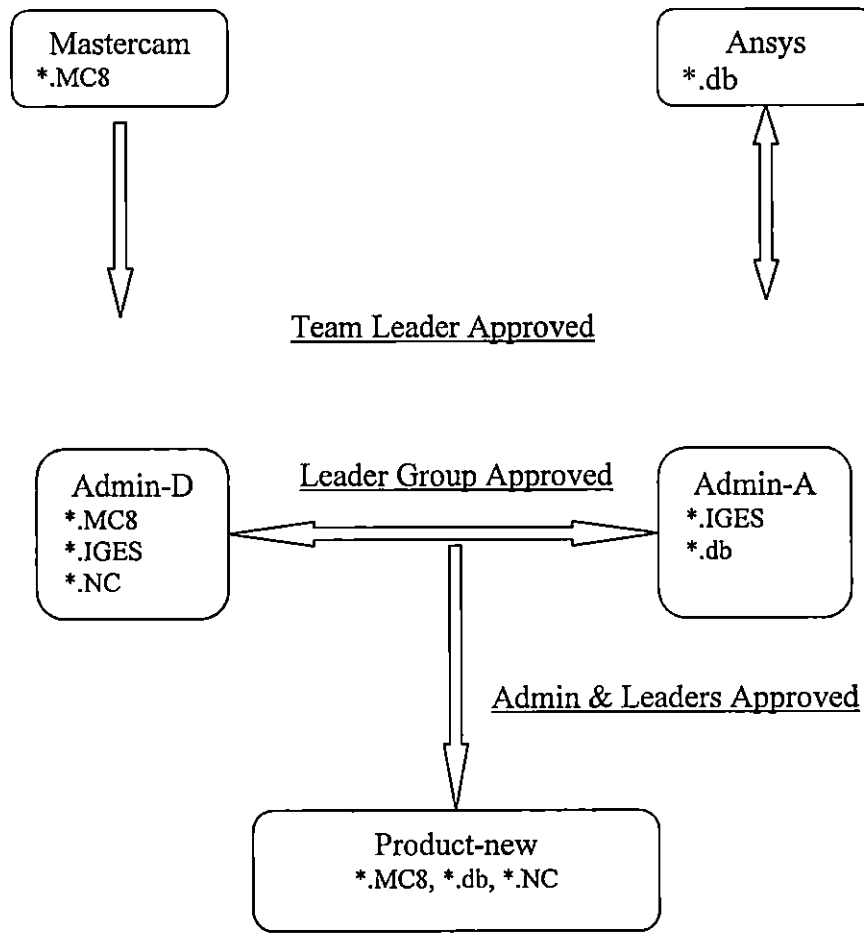


Figure 83. Product Information Flow in Dfs.

The following steps explain the product information flow in this Dfs .

1. Parts were designed by team members of Designers using Mastercam. Drafts were saved as MC8 files in the 'Mastercam' Dfs folder.
2. Drafts, approved or modified by team leaders, were converted from MC8 files to IGES files and saved in the 'Admin-D' Dfs folder.
3. The team leader of Analyzers transfered the IGES files from 'Admin-D' Dfs folder to the 'Admin-A' and 'Ansys' Dfs folders, so they could be used by team members from the analyzing team.
4. Team members analyzed the part models and saved the results into the 'Ansys' Dfs folder.
5. Brainstorm discussions were held to analyze and verify the results from team members.
6. The team leader saved the approved results into the 'Admin-A' Dfs folder.
7. The team of Designers discussed the ANSYS results. Changes were made to the part models according to the results.
8. Administrator and team leaders held a verification meeting after changes had been made. Then a final model for the new part was saved to the 'Product-new' Dfs folder. The NC code was generated for the manufacturing process.
9. Designers and analyzers then viewed the final model and provided feedback information about it through the LAN network.

The whole process was completed within the Project.com domain and all product information was saved and managed by the Dfs system. The efficiency and security were provided by both the hardware and software systems of the Project.com domain.

Design Part Model

For this study, a gravity car model was designed with Mastercam, using the following procedure.

1. Start the Mastercam8.1 program.
2. Choose *MAIN MENU* > *File* > *Get*, open the concept car template file.
3. Choose *MAIN MENU.*
4. Choose *Level* from the Secondary Menu. The *Level Manager* window opens.
5. Double-click on the number *10* to make the Splines line active.
6. Choose *All* for List Levels and choose *All off* for Visible Levels.
7. In the Visible column, select *Level1, Z depth 0"* as shown in Figure 84. Click *OK.*

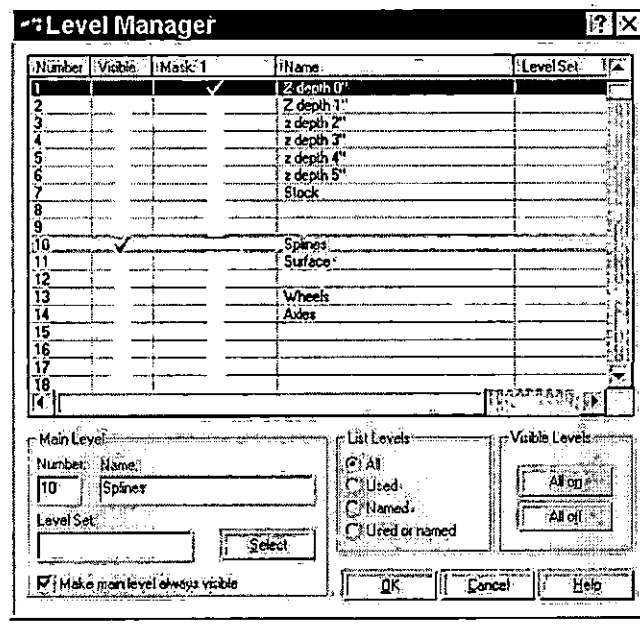


Figure 84. Level Manager Window.

8. Choose the *Gview* button from the toolbar.

9. Choose the *Cplane* button from the toolbar.

10. Choose the *Fit* button on the toolbar to center the geometry.

11. Choose *Color* from the Secondary Menu. Enter 10 (green) as shown in Figure 85.

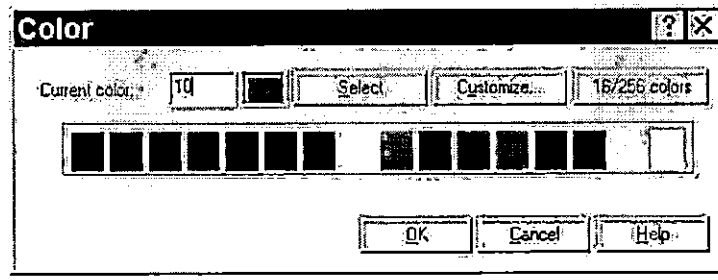


Figure 85. Color Window.

12. Choose *Z* from the Secondary Menu. Enter *0* as the new construction depth.

13. Righ-click in the graphic window and deselect *AutoCursor* in the menu.

In this design, the shape of the car was defined by creating 6 splines. The left side of the car was created and then mirrored to create the other side as shown in the following steps.

14. Choose *MAIN MENU > Create > Spline > Manual.*

15. Start the spline by clicking in the upper part of the red box and ending up in the green box. Press *Esc* to complete.

16. Choose *MAIN MENU > Modify > Trim > 1 Entity.*

17. Select the line to trim to and the part to keep.

18. Choose *Z* from the Secondary Menu. Enter *1* as the new construction depth.

19. Choose *Level* from the Secondary Menu. In the Visible column, deselect *Level 1*, Z depth 0".

20. Select Level 2, Z depth1 as shown in Figure 86. Click *OK.*

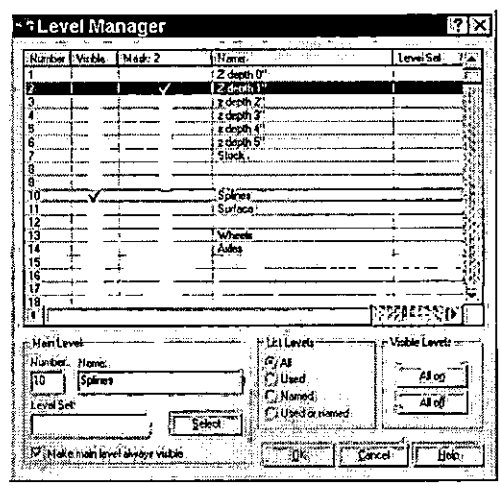


Figure 86. Level Manager Window.

21. Choose *Color* from the Secondary Menu. Enter *11* to set the color to light blue.

22. Choose *MAIN MENU > Create > Spline > Manual > Sketch.*

23. Start the spline by clicking in the red box and ending up in the green box. Each point should be to the left and below the proceeding point. Press *Esc.*

24. Trim the spline to the blue rectangle as before.

25. Choose *Z* from the Secondary Menu.

26. Enter *2* as the new construction depth. Choose *Level* from the menu.

27. In the Visible column, deselect *Level 2, Z depth 1*.Select *Level 3, Z depth 2"* as shown in Figure 87. Click *OK.*

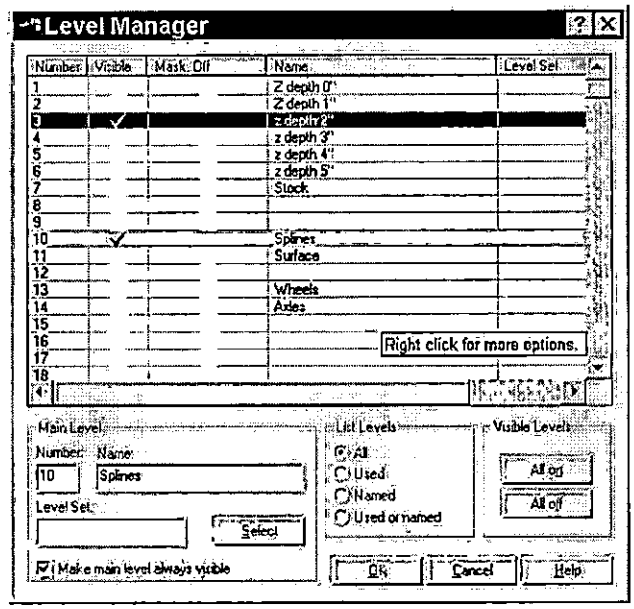


Figure 87. Level Manager Window.

28. Choose *Color* from the Secondary Menu. Change the color to 12 to set it to red.

29. Choose *MAIN MENU > Create > Spline > Manual.*

30. Draw a spline, starting in the red box and ending up in the green box.

31. Trim the spline to the blue rectangle.

32. Set Level 4, Z depth 3" in the *Level Manager* window as shown in Figure 88.

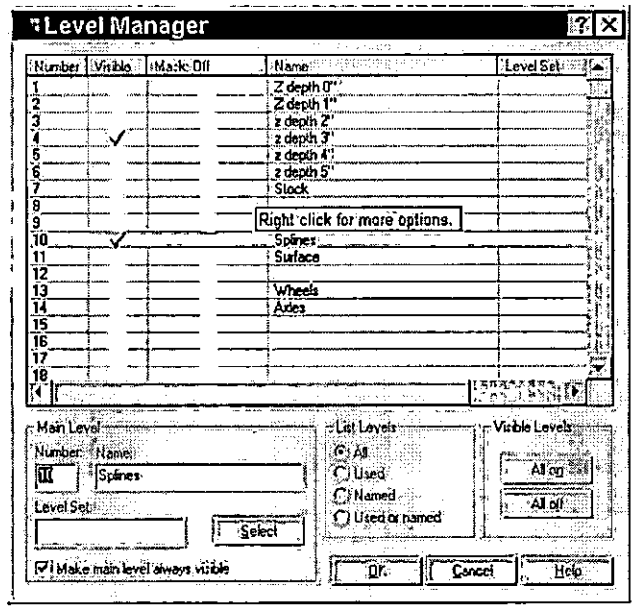


Figure 88. Level Manager Window.

33. Choose *Color*; enter 13 to set the color as purple.

34. Choose *MAIN MENU > Create > Splien > Mnaual.*

35. Draw the spline starting in the top red rectangle and ending in the bottom green rectangle, press *Esc*. Trim the spline.

36. Set Level *5*, Z depth *4"* in the *Level Manager.*

37. Set color to *14* as yellow.

38. Choose *MAIN MENU > Create > Splien > Mnaual.*

39. Draw the spline, staying out of the axle hole. Press *Esc*. Trim the spline.

40. Set Level *6*, Z depth *5"* in the *Level Manager.*

41. Set color to *15* as white.

42. Choose *MAIN MENU* > *Create* > *Splien* > *Mnaual.*

43. Draw a small spline, starting in the bottom left of the red rectangle and ending in the top right corner of the green rectangle.

44. Press *Esc* to complete the spline. Trim the spline.

45. The splines created should be as shown in Figure 89.

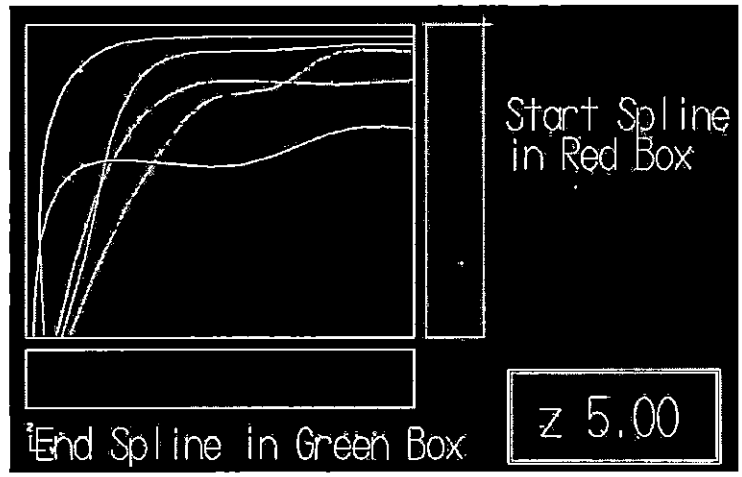


Figure 89. Splines Created In Mastercam.

46. Choose *Level*. Double-click on the number *11* to set *Surface line* active.

47. Choose *All off* for Visible Levels. Select *Line 10* (Splines) in the Visible column.

48. Choose the *Gview* (isometric) button from the toolbar. Choose the *Cplane* (top) button from the toolbar. Choose the *Fit* button on the toolbar to center the geometry.

49. Choose *Color*, set to 10 (green).

50. Choose *MAIN MENU > Create > Surface > Loft > Single.*

51. Select each spline in order. A wireframe representation of the surface appears.

52. Press *Alt-S* to shade the part. The surface of the part is as shown in Figure 90.

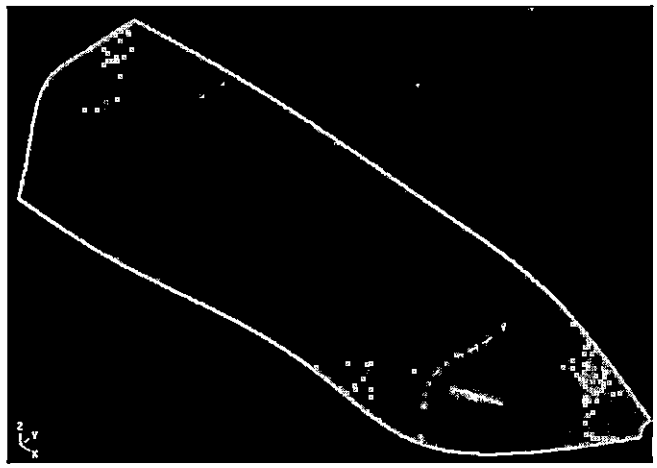


Figure 90. The Part Surface.

53. Turn the shading off by pressing *Alt-S* again.

54. Choose *MAIN MENU > Xform > Mirror.*

55. Select a line anywhere on the surface; it will highlight white.

56. Choose *Done > 2 points > Endpoint.* Select the points on the top of each end of the surface.

57. Choose Copy as shown in Figure 91. Click *OK.*

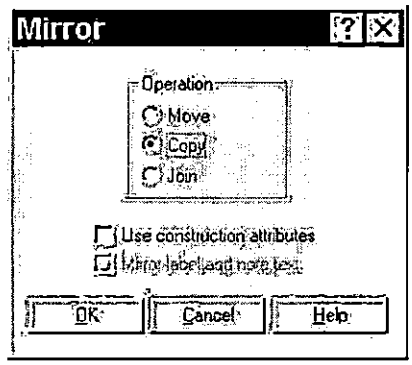


Figure 91. Mirror Window.

58. The surface is mirrored as shown in Figure 92.

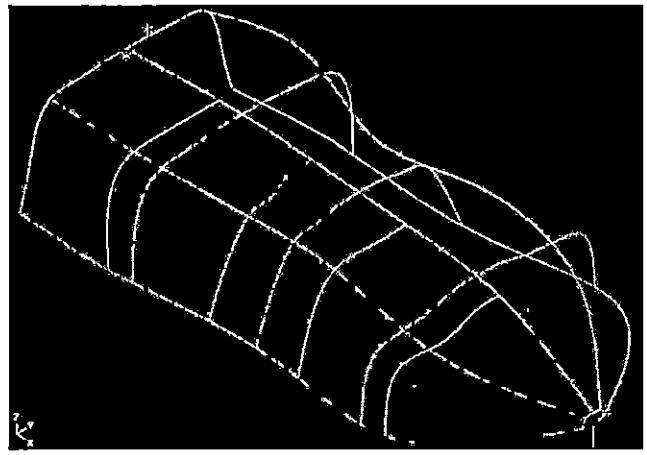


Figure 92. Mirrored Surface.

59. Fit the geometry to the screen.

60. Choose *MAIN MENU* > *Screen* > *Clr colors.*

61. Check the shape in different views using the *dynamic* icon.

62. Choose *Level.*

63. Select the *Wheels level* and the *Axles level* in the Visible column.

64. Deselect the *Splines* level. Click *OK.* Fit the geometry to the screen.

65. Press *Alt-S* to shade the part as shown in Figure 93.

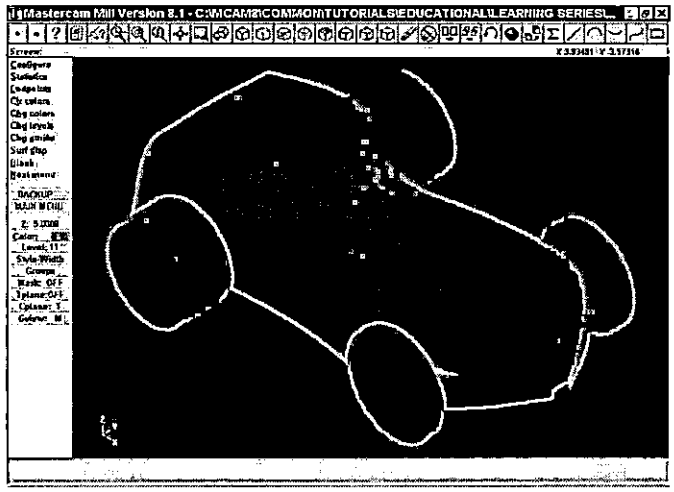


Figure 93. Part View of the Gravity Car.

66. Press *Alt-S* to remove the shading.

67. Choose *MAIN MENU* > *File* > *Save* to save the file as MC8.

68. Choose *MAIN MENU* > *Toolpaths* > *Job Setup*.

69. Enter the values as shown in Figure 94 to define the rough stock. Click *OK*.

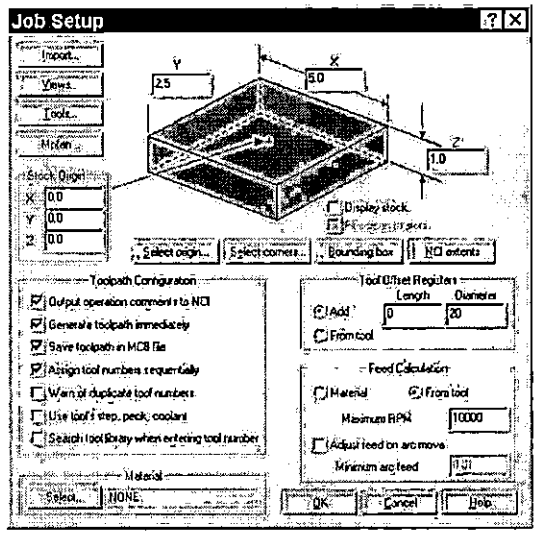


Figure 94. Job Setup Dialog Box.

70. Choose *level*. Deselect all the levels except for *Surface*. Click *OK*.

71. Choose *Surface* > *Finish* > *Flowline*.

72. Select a point on the surface and choose *Done*.

73. Right-click in the tool display area and choose the *ball endmill*.

74. Enter the values as shown in Figure 95 to define the tool.

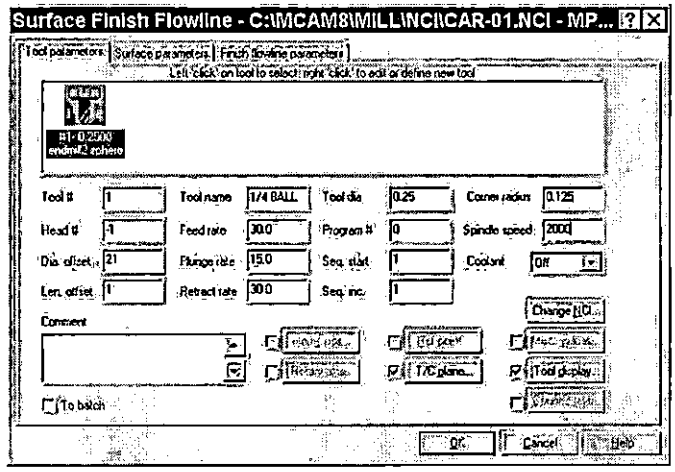


Figure 95. Tool Parameters Dialog Box.

75. Choose the *Surface parameters* tab. Enter the values as shown in Figure 96.

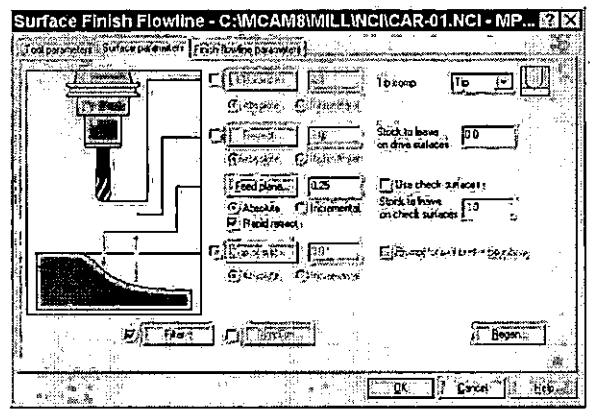


Figure 96. Surface Parameters Dialog Box.

76. Select the *Filter* button and enter the values as shown in Figure 97.

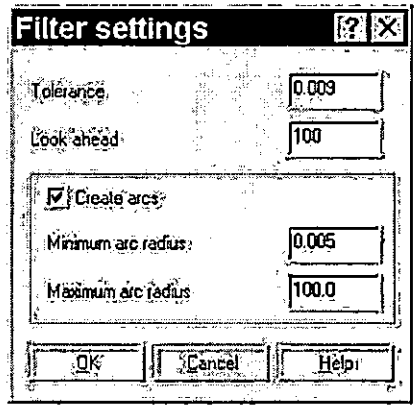


Figure 97. Filter Settings Dialog Box.

77. Select the *Finish flowline parameters* tab.

78. Enter the values as shown in Figure 98.

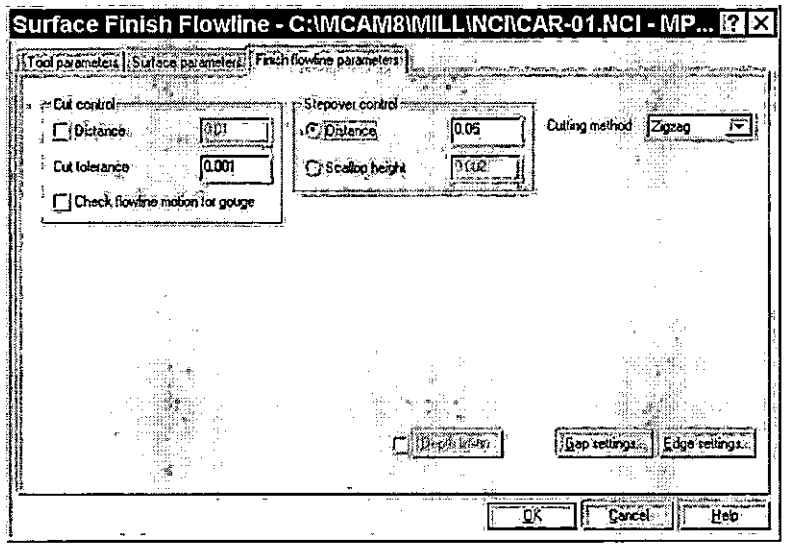


Figure 98. Finish Flowline Parameters Dialog Box.

79. Click *OK.*

80. Toggle *Offset* by clicking it several times. Toggle it so the offset display line is outside of the car.

81. Toggle *Cut dir* several times by clicking the mouse. Toggle it so it is parallel to the length, with the larger arrow pointing down the length of the car.
82. Toggle *Step dir* to move the toolpath starting point to the center of the car.
83. Toggle *Start* to move the starting point to the back of the car.
84. Choose *Done*.
85. Choose *Finish* > *Flowline*. Select the surface on the opposite side of the car.
86. Enter the same values in the next three dialog boxes as were shown in the first flowline toolpath.
87. Toggle *Offset* to move the toolpath outside the car.
88. Toggle *Cut dir* to change the cutting direction to lengthwise.
89. Toggle *Step dir* to change the toolpath starting point to the top of the car.
90. Toggle *Start* to move the starting point to the back of the car. Click *Done*.
91. Choose *Level*. Deselect all levels except Stock and Surface. Click *OK*.
92. Choose *MAIN MENU* > *Toolpaths* > *Operations* > *Select All*.
93. Press *Alt-O* to open the *Operations Manager* as shown in Figure 99.

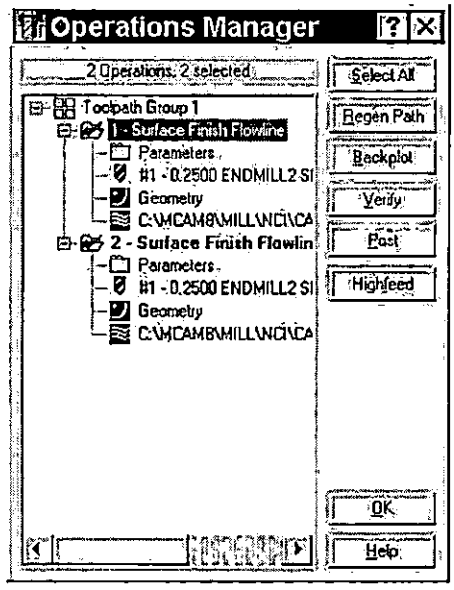


Figure 99. Operations Manager Window.

94. Choose the *Verify* button from the *Operations Manager*. The *Verify* toolbar will appear as shown in Figure 100.

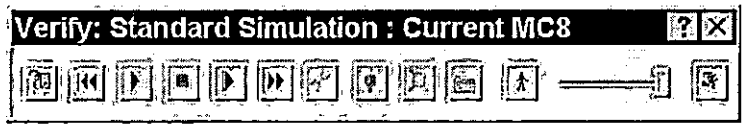


Figure 100. Verify Toolbar.

95. Choose the *Configure* button from the *Verify* toolbar.

96. Select the *Use Job Setup values* button in the dialog box and enter the values as shown in Figure 101.

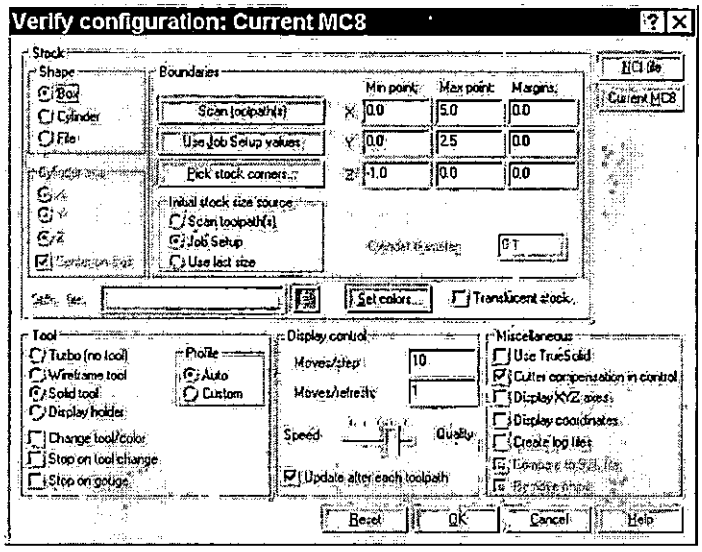


Figure 101. Verify Configuration Window.

97. Click *OK*. Choose the *Machine* button from the *Verify* toolbar. The machined part will appear as in Figure 102.

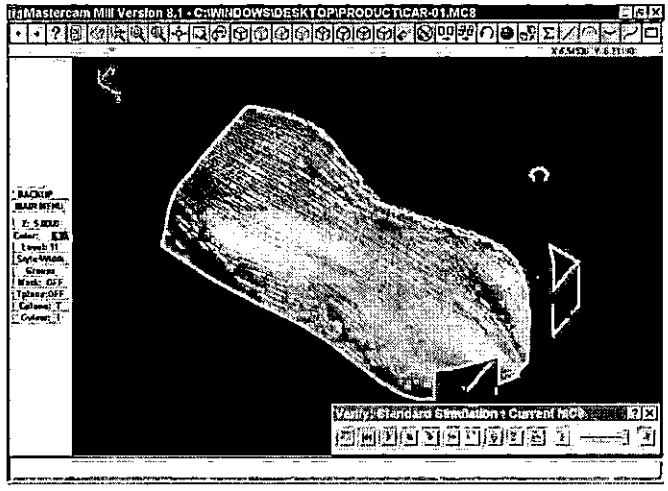


Figure 102. The Machined Part.

98. Save the MC8 file again.

Convert Product File

The design drafts for the product model were verified in team meetings, and the approved draft was saved in the 'Admin-D' Dfs folder. The MC8 file of the product model was converted to an Initial Graphics Exchange Specification (IGES) file in preparation for analyzing by ANSYS. This is a neutral format for 2D or 3D CAD/CAM product models, drawings, or graphics. Both Mastercam8.1 and ANSYS5.7 have the IGES program integrated, and can read and write IGES files from the original file generated by them. In this study, the product model data was converted from MC8 format to IGES format using the IGES integrated in Mastercam8.1. Then ANSYS5.7 imported the IGES file and read it as a db file.

Converting the Product Model Data from MC8 to IGES

1. Start the Mastercam8.1 program and open the product MC8 file to be converted.
2. Click on *MAIN MENU* to open it.
3. In the *MAIN MENU*, choose *File* as shown in Figure 103.

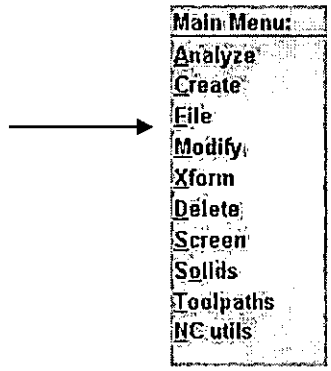


Figure 103. MAIN MENU of Mastercam8.1.

4. In the *File* menu, choose *Converters* as shown in Figure 104.

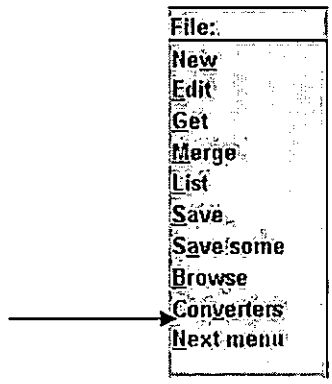


Figure 104. File Menu of Mastercam8.1.

5. In the *Converters* menu, choose *IGES* as shown in Figure 105.

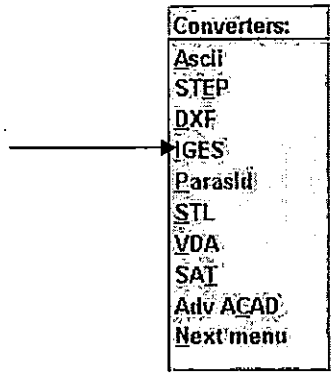


Figure 105. Converters Menu of Mastercam8.1.

6. In the *IGES* menu, choose *Write file* as shown in Figure 106.

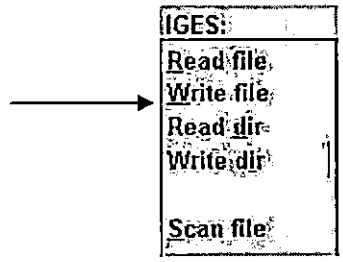


Figure 106. IGES Menu of Mastercam8.1.

7. Then the window of *Specify File Name to Write* appears as shown in Figure 107. Specify the file name and the directory where you want the file to be saved.

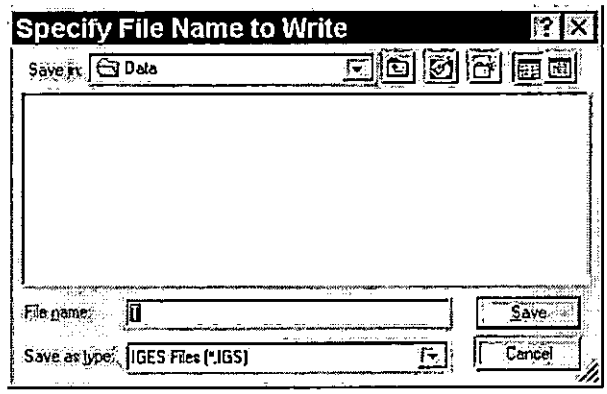


Figure 107. Specify File Name to Write Window.

After a few minutes processing time, the whole product data is written in IGES format.

Reading the IGES File into the ANSYS Program

1. Start the ANSYS program. Choose *File* from the utility menu.
2. In the *File* menu, choose *Import* as shown in Figure 108.

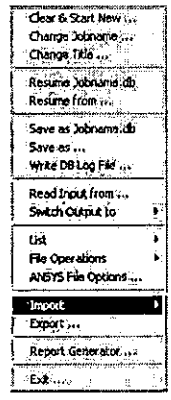


Figure 108. File Menu of ANSYS5.7.

3. Choose *IGES* from the pulled down menu as shown in Figure 109.

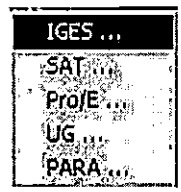


Figure 109. Down Menu of Import.

4. The *Import IGES File Window* appears.

5. Select items as shown in Figure 110.

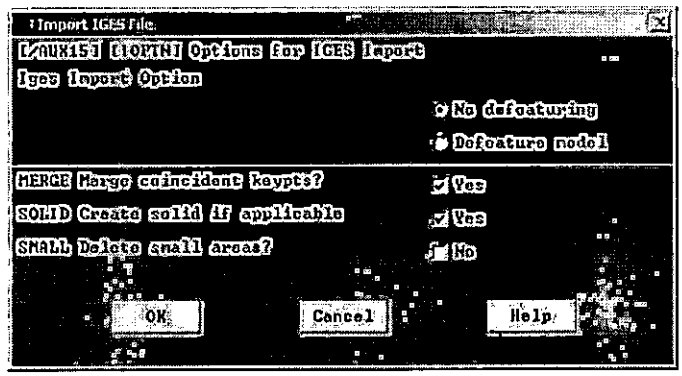


Figure 110. Import IGES File Window.

6. Click *OK*. At the Import IGES File Path window, select the file name, the directory and the drive from where you want the IGES file imported as shown in Figure 111.

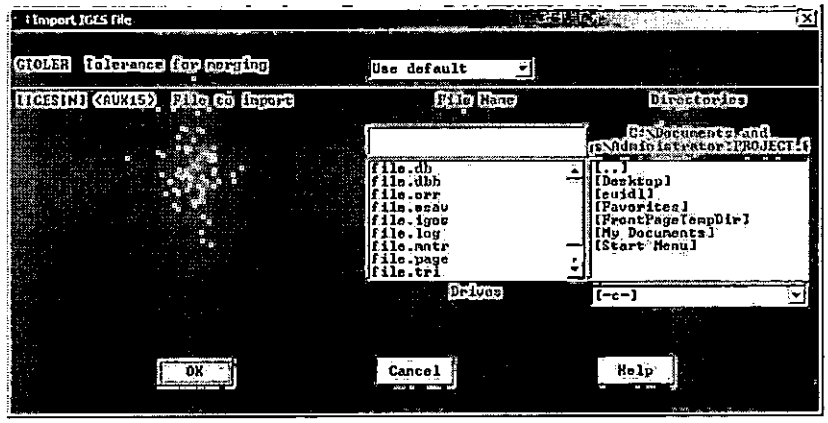


Figure 111. Import IGES File Window.

7. When the processing is complete, the ANSYS program opens the IGES file. Then save it as an ANSYS-generated database (db) file.

Analyze Part Model

In this part of the simulation, the car shell model was analyzed as a structural analysis example. Since the model is symmetrical along the middle line, half of the model was analyzed in the analysis example, using the following procedure.

Problem Description

This is a structural analysis of the shell model of a gravity car. The objective of the problem is to demonstrate the car's contour deformation and stress distribution under a certain moment force.

Problem Specifications

The car is made of low-density polyethylene with the following values:

Young's modulus = 3800

Poisson's ration = 0.3

The element type selected for this example is SHELL93. SHELL93 is particularly well suited for modeling curved shells. The element has six degrees of freedom at each node: translations in the nodal x, y, and z directions and rotations about the nodal x, y, and z-axes. The element has plasticity, stress stiffening and strain capabilities.

Preprocessor Phase

1. Start the ANSYS5.7 program and open the model file as shown in Figure 112.

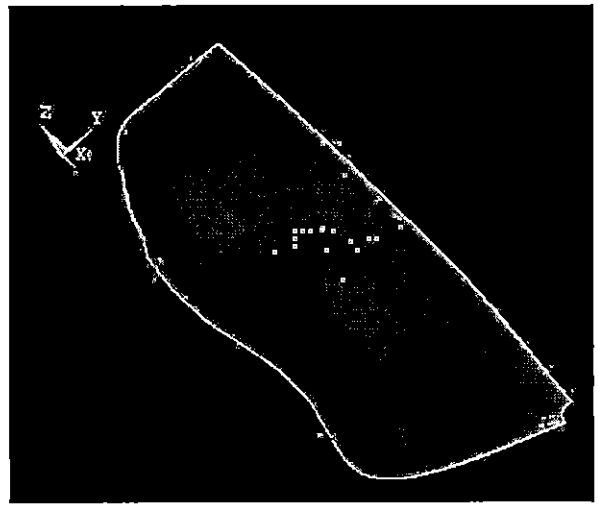


Figure 112. Shell Model of the Gravity Car.

2. Select the menu path *Utility Menu* > *File* > *Change Title*.
3. In the *Change Title* Dialog box, type in *Car Model* to set a title for the problem as shown in Figure 113.

Figure 113. Change Title Dialog Box.

4. Select the menu path *Utility Menu* > *File* > *Change Jobname*.

5. In the *Change Jobname* Dialog box, type in *car* as the Jobname, as shown in Figure 114.

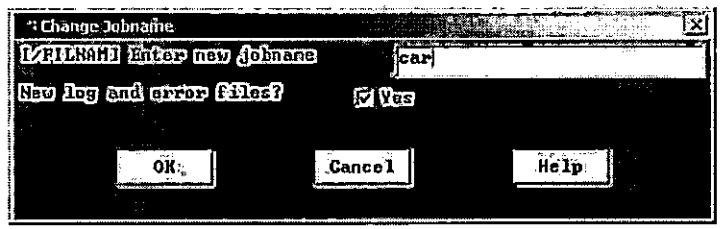


Figure 114. Change Jobname Dialog Box.

Define the element type.

6. Select *Main Menu* > *Preprocessor* > *Element Type* > *Add/Edit/Delete*. The *Element Types* dialog box appears.

7. Click on *Add*. The *Library of Element Types* dialog box appears as shown in Figure 115.

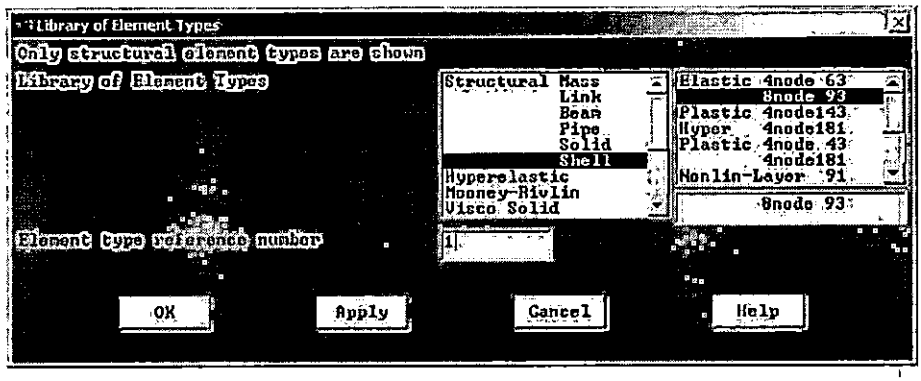


Figure 115. Library of Element Types Dialog Box.

8. In the left scroll box, click on *Structural Shell*. In the right scroll box, click on *Elastic 8node* 93, setting the Element Type as *SHELL93*. Click *OK*.

9. In the *Element Type* dialog box lists the Element Type as shown in Figure 116.

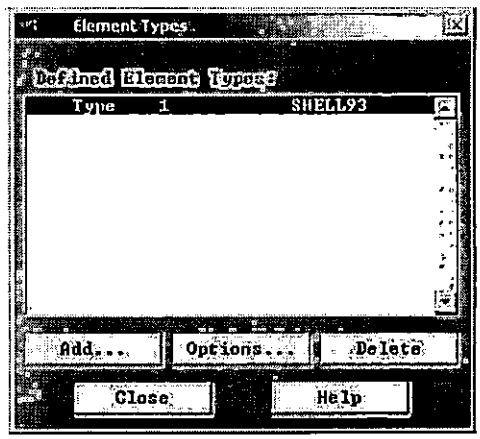


Figure 116. Element Types Dialog Box.

10. Click *Close.*

Define Real Constants.

11. Select *Main Menu > Preprocessor > Real Constants > Add/Edit/Delete.*

12. Enter the Shell thickness for each node as *0.1* as shown in Figure 117.

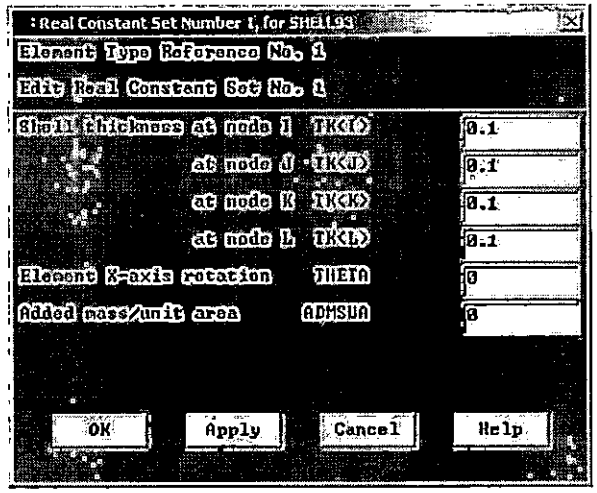


Figure 117. Real Constant Defining Window.

13. Click *OK*. The set number is displayed as shown in Figure 118.

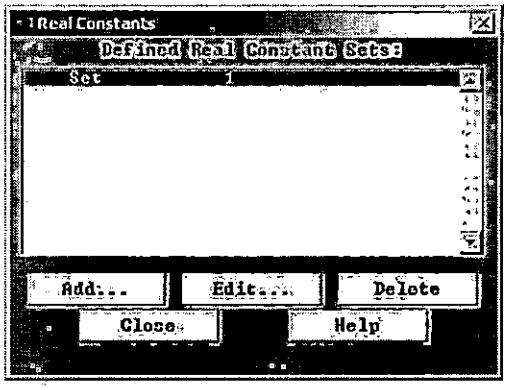


Figure 118. Real Constants Display Window.

Define the element material properties.

14. Select *Main Menu > Preprocessor > Material Props > Material Models.*

    The *Define Material Model Behavior* Window appears as shown in Figure 119.

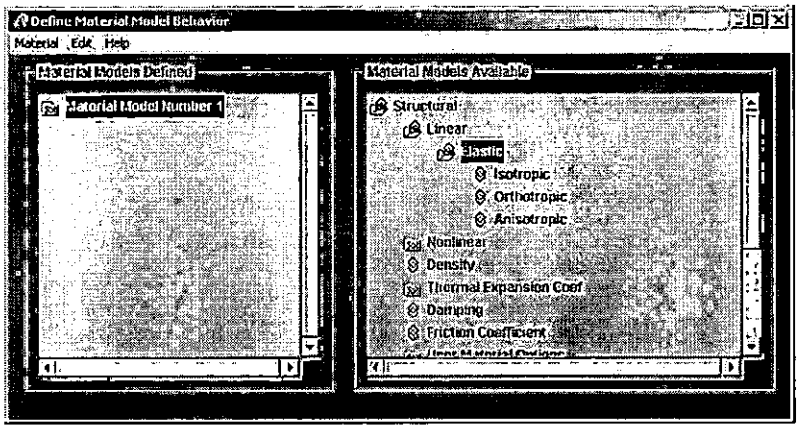


Figure 119. Define Material Model Behavior Window.

15. Double-click on *isotropic* to select it as the material property for the model.

16. Enter the properties of this material: *EX 3800, PRXY 0.3,* as prompted.

Meshing.

17. To tell ANSYS how big the elements should be, select *Preprocessor* > *(-Meshing-) Size Cntrls* > *(-Areas) All Areas.*

18. Select an element edge length of 1 as shown in Figure 120. Click *OK*

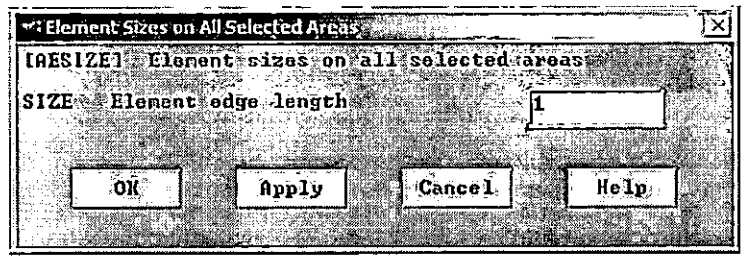


Figure 120. Element Sizes On All Selected Areas Dialog Box.

19. Select *Preprocessor* > *Mesh* > *(-Areas-) Mapped* and select the area when prompted.

20. The meshed shell model then appears as shown in Figure 121.

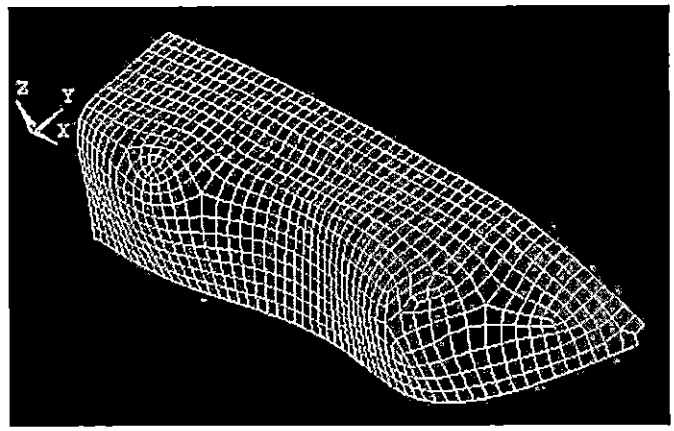


Figure 121. The Meshed Shell Model.

Solution Phase

In this phase the loads and constraints are applied and the problem is solved.

Define the analysis type.

1. Select *Main Menu > Solution > New Analysis*. The *New Analysis* window appears as shown in Figure 122.

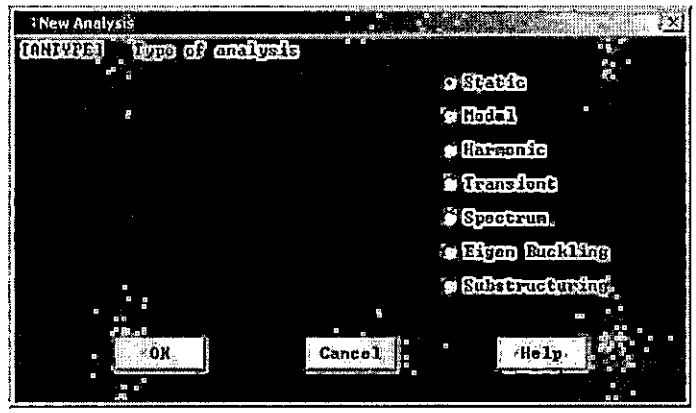


Figure 122. New Analysis Window.

2. Select Type of analysis as Static. Click OK.

Apply Constraints.

In order to find out the deformity and stress capability of the car shell, the end of the shell is set as fixed line before the load is applied.

3. Select *Main Menu > Solution > (-Loads-) Apply > (-Structural-) Displacement > 'On Lines'*.
4. Select the end line of the shell model by clicking on it. Fill in the Apply U,ROT on Lines window as shown in Figure 123.

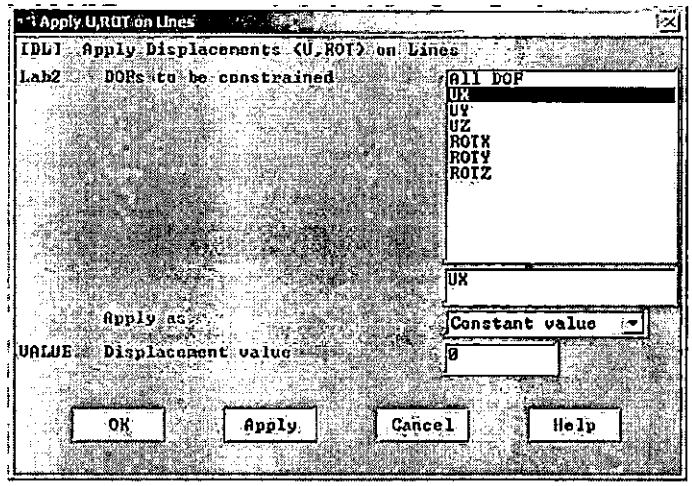


Figure 123. Apply U.ROT on Lines Window.

5. Click on *Apply*. The UX DOF of the nodes in the end line of the model is limited to zero, meaning that the nodes will not have displacement along the x-axle direction. Some blue triangles appear in the graphics window indicating the displacement constraints as shown in Figure 124.

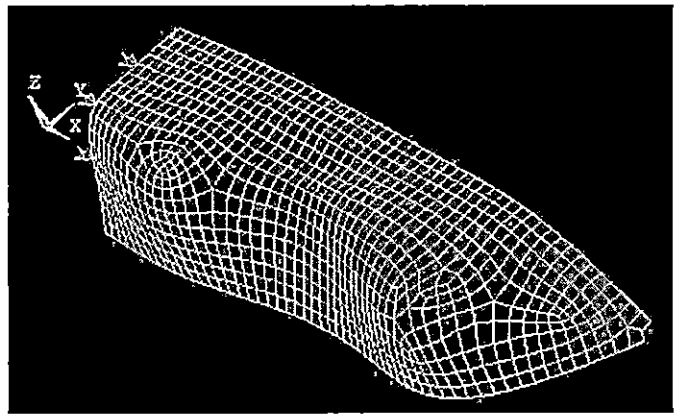


Figure 124. Shell Model with Constraint Applied.

Apply loads.

6. Select *Solution* > *(-Loads-) Apply* > *(-Structural-) Force/Moment* > *On Nodes*.

7. The *Apply F/M on Nodes* window appears as shown in Figure 125.

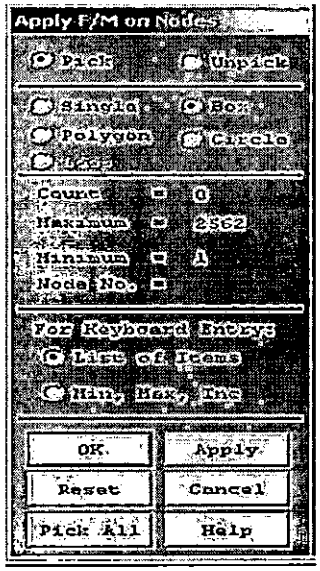


Figure 125. Apply F/M on Nodes Window.

8. Select *Box* item. Pick nodes by clicking mouse to include all needed nodes in the box. In this example, the front part is selected. Click *OK*.

9. Fill in the *Apply F/M on Nodes* window as shown in Figure 124.

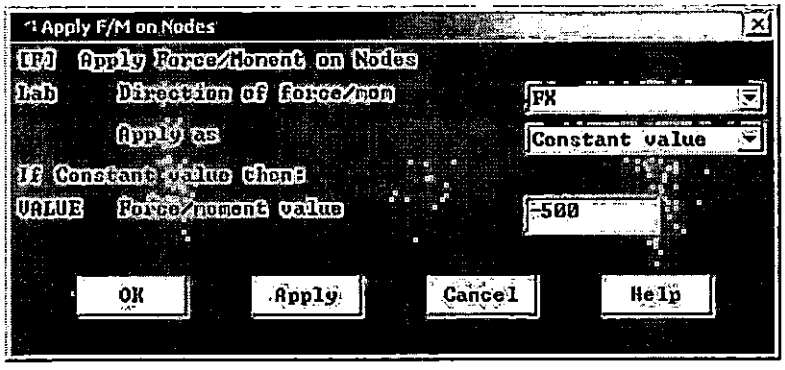


Figure 126. Apply F/M on Nodes Settings Window.

10. The applied force and constraints now appear as shown in Figure 127.

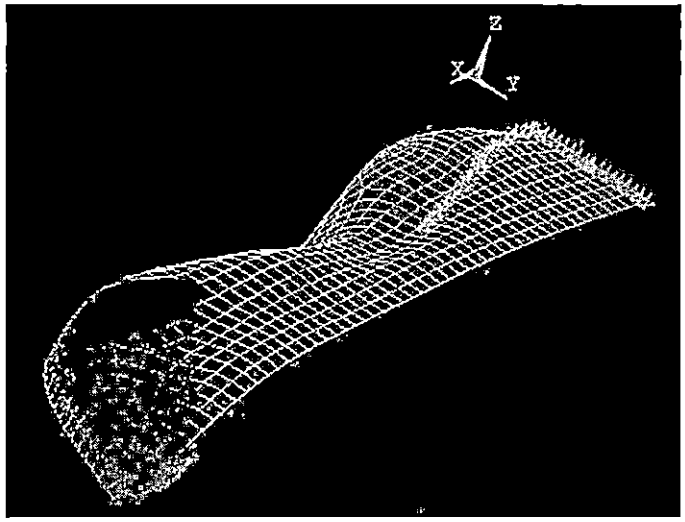


Figure 127. The Shell Model with Applied Loads.

Solving the System.

11. Select *Solution* > *(-Solve-) Current LS.* The *Solve Current Load Step* window appears as shown in Figure 128. Click *OK.*

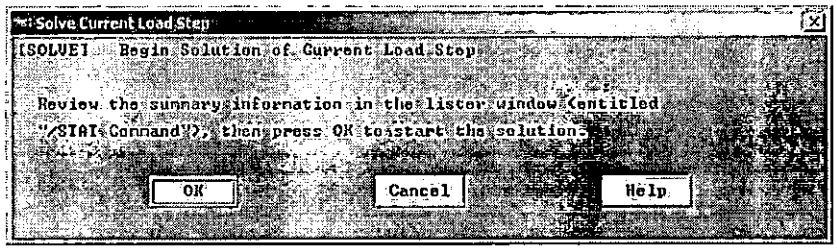


Figure 128. Solve Current Load Step Window.

12. When processing is complete, a message appears indicating the solution is done, as shown in Figure 129.

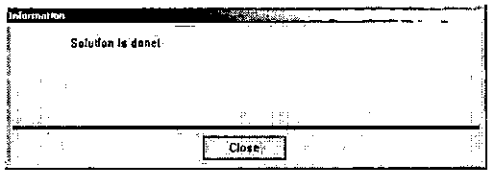


Figure 129. 'Solution is done!' Information Screen.

13. The *Status Command* window then appears indicating solution status as shown in Figure 130.

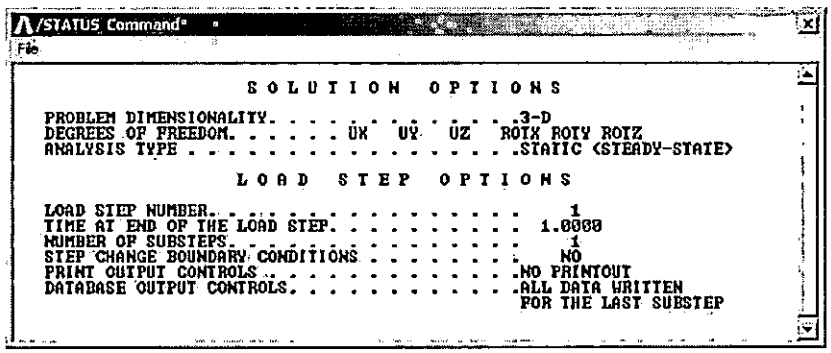


Figure 130. Status Command Window.

Postprocessing Phase

In the Postprocessing Phase, analysis results are plotted by graphics or listed by text windows.

1. Select *Main Menu* > *General Postproc* > *Plot Results* > *Deformed Shape*. The *Plot Deformed Shape* dialog box appears.
2. Select *Def + undeformed* to display the deformed shell under the moment force as shown in Figure 131. The shell mesh is deformed when the 500N moment force is applied on the front part of the car shell model.

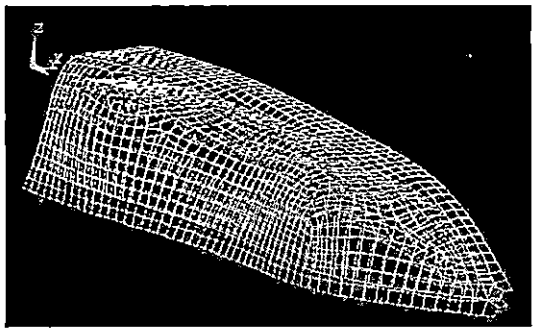


Figure 131. Deformed Shell Model.

3. Select *Plot Results > (-Contour Plot-) Nodal Solution.* The *Contour Nodal Solution Data* dialog box appears as shown in Figure 132.

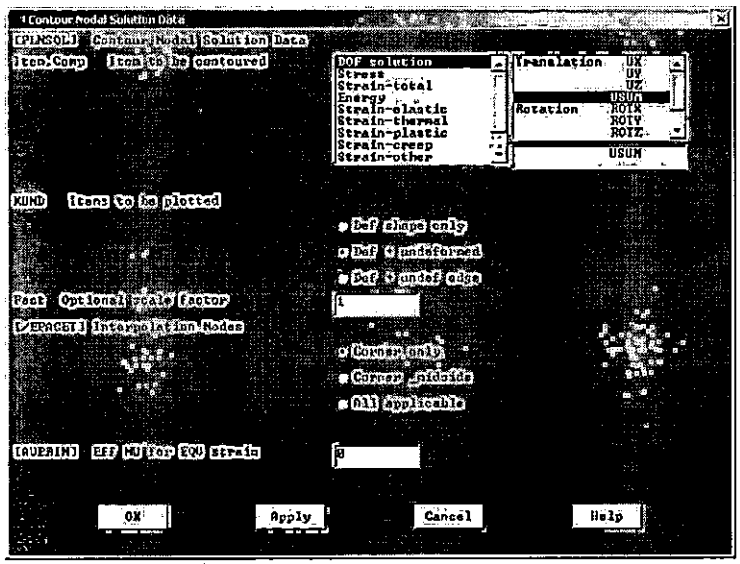


Figure 132. The Contour Nodal Solution Data Dialog Box.

4. Select *DOF solution, USUM,* to contour the nodal solution with six degrees of freedom. In the Item to be plotted, select *Def + undeformed* to display both the deformed shell model and the undeformed one. Click *OK.*

5. The graphic of nodal solution appears as shown in Figure 133.

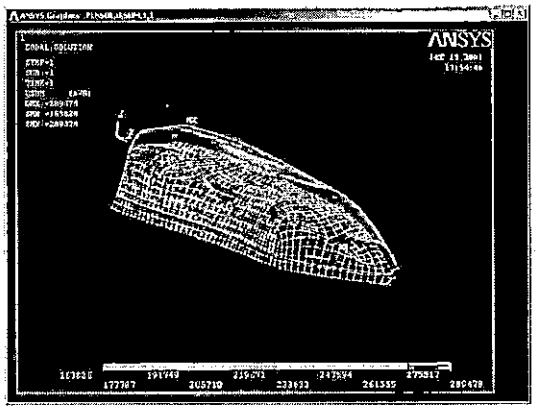


Figure 133. Graphic of Nodal Solution Window.

The graphic of nodal solution shows that the biggest change of DOF happened to the nodes that are in the backside of the shell mode as shown in the red area. This indicates that this area will be broken easily.

6. Select *Plot Results* > *(-Contour plot-) Element Solution.*
7. Select *Stress, X-direction SX* to plot the stress of X-direction on the shell model.
8. Select *Def + undeformed* to plot the deformed shell model and undeformed one under the stress. Click *OK.*
9. The graphic of element solution appears as shown in Figure 134.

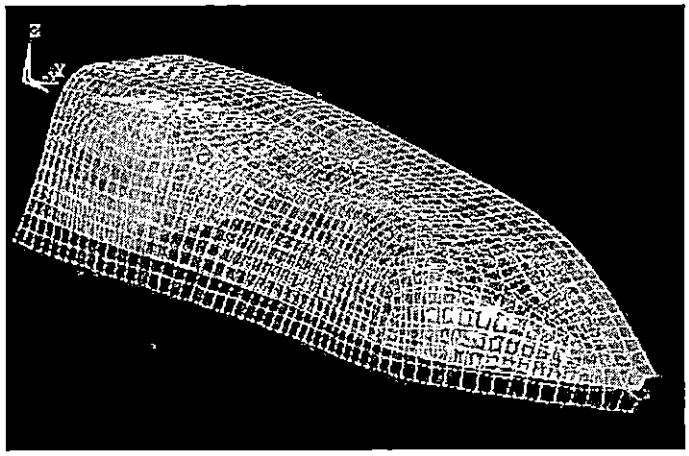
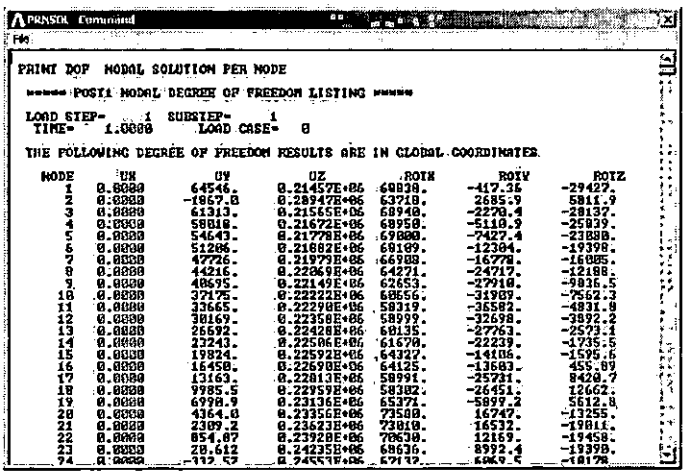


Figure 134. The Graphic of Element Solution.

In the graphic of element solution, the distribution of stresses on the shell model of the gravity car is displayed by areas with different colors.

10. Select *Main Menu* > *General Postproc* > *List Results* > *Nodal Solution.*
11. The DOF nodal solution list is displayed as shown in Figure 135. The degree of freedom results from each node are displayed in detail in global

coordinates. From this list, one can figure to what extent the node's DOF will be changed under the moment force.



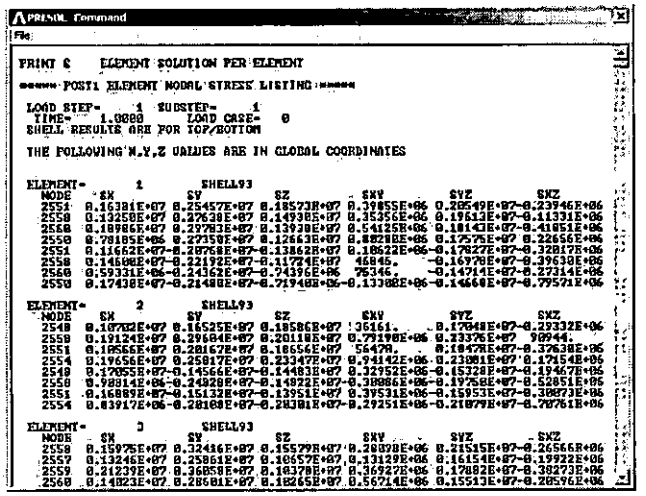
PRNSOL Command

File

```
PRINT DOF  NODAL SOLUTION PER NODE

***** POST1 NODAL DEGREE OF FREEDOM LISTING *****

LOAD STEP=     1  SUBSTEP=     1
 TIME=   1.0000      LOAD CASE=   0

THE FOLLOWING DEGREE OF FREEDOM RESULTS ARE IN GLOBAL COORDINATES.

 NODE      UX          UY          UZ          ROTX        ROTY        ROTZ
    1  0.0000      64546.      0.21457E+06   60838.     -417.35     -29427.
    2  0.0000     -1967.8     0.28947E+06   63718.      2685.9      5811.9
    3  0.0000      61313.      0.21565E+06   60940.     -2270.4     -28137.
    4  0.0000      58818.      0.21672E+06   60950.     -5110.9     -25939.
    5  0.0000      54643.      0.21778E+06   60980.     -7427.4     -23888.
    6  0.0000      51286.      0.21882E+06   60109.     -12304.     -19398.
    7  0.0000      47726.      0.21979E+06   60903.     -16778.     -16085.
    8  0.0000      44216.      0.22069E+06   60271.     -24717.     -12188.
    9  0.0000      40695.      0.22149E+06   62653.     -27910.     -9036.5
   10  0.0000      37175.      0.22222E+06   60656.     -31989.     -7562.3
   11  0.0000      33665.      0.22290E+06   58319.     -36582.     -4831.8
   12  0.0000      30169.      0.22350E+06   58999.     -32698.     -2892.2
   13  0.0000      26692.      0.22402E+06   60135.     -27763.     -2573.1
   14  0.0000      23243.      0.22506E+06   61670.     -22239.     -1735.5
   15  0.0000      19824.      0.22592E+06   60327.     -14106.     -1595.6
   16  0.0000      16450.      0.22690E+06   60125.     -13603.      455.89
   17  0.0000      13163.      0.22813E+06   58991.     -25731.      8420.7
   18  0.0000      9985.5      0.22959E+06   58382.     -26451.      12662.
   19  0.0000      6998.9      0.23136E+06   65271.     -5899.2      5612.8
   20  0.0000      4364.6      0.23356E+06   73508.      16747.     -13255.
   21  0.0000      2309.2      0.23623E+06   73010.      16532.     -19811.
   22  0.0000      854.87      0.23928E+06   70630.      12169.     -19458.
   23  0.0000      28.612      0.24235E+06   68636.      8992.4     -19398.
   24  0.0000     -112.59      0.24557E+06   67179.      6869.6     -18178.
```

Figure 135. The List of DOF Nodal Solution.

12. Select *List Results* > *Stress Solution*. In the *Element Nodal Solution Listing*, as shown in Figure 136, the stress results are listed for each element. With each element, the stress distribution of all DOF for each node is displayed in detail.



PRNSOL Command

File

```
PRINT S    ELEMENT SOLUTION PER ELEMENT

***** POST1 ELEMENT NODAL STRESS LISTING *****

 LOAD STEP=     1  SUBSTEP=     1
  TIME=   1.0000      LOAD CASE=   0
 SHELL RESULTS ARE FOR TOP/BOTTOM

 THE FOLLOWING X,Y,Z VALUES ARE IN GLOBAL COORDINATES

 ELEMENT=       1      SHELL93
   NODE      SX          SY          SZ          SXY         SYZ         SXZ
   2551  0.16381E+07 0.25457E+07 0.18573E+07 0.39855E+06 0.20549E+07-0.23946E+06
   2558  0.13250E+07 0.27638E+07 0.14930E+07 0.35256E+06 0.17613E+07-0.11331E+06
   2548  0.10885E+07 0.29761E+07 0.13938E+07 0.54125E+06 0.18143E+07-0.41612E+06
   2550  0.78185E+06 0.27150E+07 0.12663E+07 0.88218E+06 0.17575E+07 0.22656E+06
   2551  0.11662E+07-0.20768E+07-0.13862E+07 0.18622E+06-0.17827E+07-0.32817E+06
   2558  0.14580E+07-0.22192E+07-0.11724E+07  46846.     -0.16978E+07-0.39638E+06
   2548  0.59331E+06-0.24362E+07-0.94396E+06  75346.     -0.14714E+07-0.27314E+06
   2550  0.17438E+07-0.21480E+07-0.71948E+06-0.13308E+06-0.14664E+07-0.79571E+06

 ELEMENT=       2      SHELL93
   NODE      SX          SY          SZ          SXY         SYZ         SXZ
   2548  0.10782E+07 0.16525E+07 0.18586E+07  36161.      0.17648E+07-0.29332E+06
   2558  0.19124E+07 0.29604E+07 0.20118E+07 0.79198E+06 0.23376E+07  90944.
   2551  0.18566E+07 0.28167E+07 0.18656E+07  56478.      0.18478E+07-0.37638E+06
   2554  0.19656E+07 0.25817E+07 0.23347E+07 0.94142E+06 0.23081E+07 0.17154E+06
   2548  0.17055E+07-0.14566E+07-0.14483E+07 0.32752E+06-0.15328E+07-0.19467E+06
   2558  0.98914E+06-0.24028E+07-0.14972E+07-0.30886E+06-0.19758E+07-0.52851E+06
   2551  0.16889E+07-0.15132E+07-0.13951E+07 0.39531E+06-0.15953E+07-0.30873E+06
   2554  0.83917E+06-0.28168E+07-0.24301E+07-0.29251E+06-0.21079E+07-0.70761E+06

 ELEMENT=       3      SHELL93
   NODE      SX          SY          SZ          SXY         SYZ         SXZ
   2558  0.15975E+07 0.32416E+07 0.15579E+07 0.28038E+06 0.21515E+07-0.26566E+06
   2557  0.13246E+07 0.25861E+07 0.10657E+07 0.13129E+06 0.16154E+07-0.19922E+06
   2559  0.21239E+07 0.36858E+07 0.18378E+07 0.36927E+06 0.17882E+07-0.38273E+06
   2560  0.14823E+07 0.28581E+07 0.18265E+07 0.56714E+06 0.15513E+07-0.20596E+06
```

Figure 136. Element Nodal Stress Listing.

Generate NC Code

When team leaders and managers have approved the product model, the NC code was generated from Mastercam8.1 to prepare for CNC machining, using the following procedure.

1. Start Mastercam8.1 program; open the MC8 file of the product model.
2. Select *MAIN MENU* > *Toolpaths* > *Operations*. The *Operations Manager* window appears as shown in Figure 137.

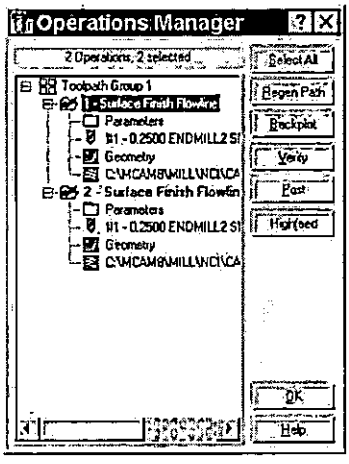


Figure 137. Operations Manager Window.

3. Select *Post* from the *Operations Manager* window. The *Post Processing* window appears as shown in Figure 138.

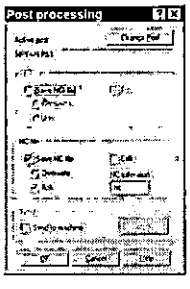


Figure 138. Post Processing Window.

4. Select *Save NC file* and check the *Ask* option in the *Post Processing* window. Click *OK*.
5. When the dialog box that requires the name of the NC file and the directory path appears, enter the file name and the directory. Click *OK*.
6. The NC code for CNC machining is generated and saved as shown in Figure 139.

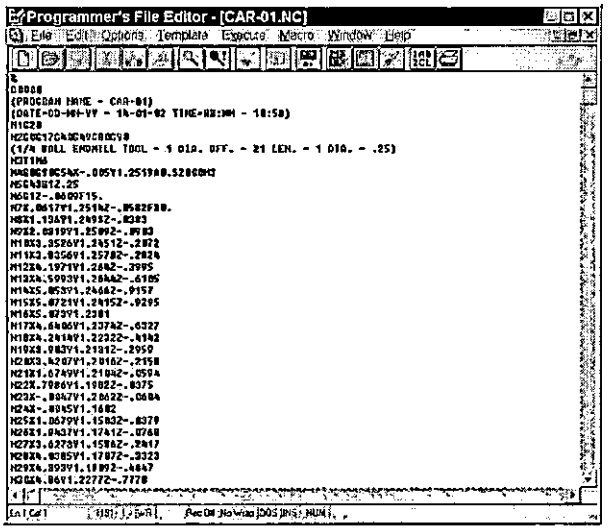


Figure 139. NC File.

Summary

In this section, a LAN for manufacturing design and product information management was constructed. The Windows 2000 Advanced server was used as the LAN operating system. Mastercam8.1 and ANSYS5.7 were integrated into the LAN as designing and analysis tools. Then to show the designing and analyzing process on the network, a gravity car model was designed and analyzed in the LAN.

CHAPTER IV

FINDINGS

Introduction

The findings from the study will be demonstrated in this chapter, with the advantages and disadvantages of the LAN analyzed in detail. The functions of Mastercam and ANSYS will be compared, and some technique problems will be listed, as well as the recommendations for future study.

Advantages of the LAN

This study is an example of applying network technology into a manufacturing system. Reviewing the experience of this simulation, advantages of this network were obviously shown, as demonstrated in the following findings.

Efficient

Paperwork was eliminated throughout the whole system. Product information was generated in the forms of MC8 files, IGES files, and db files from Mastercam8.1 and ANSYS5.7. These files were shared by users from each computer on the LAN, thereby eliminating any need for transferring paperwork or other forms of files, such as floppy disks, and tapes. The time and labor were saved for other usages.

The network, integrated with designing and analysis tools, assisted the manufacturer to realize the concurrent engineering. Data files of product models were generated and managed on the LAN. Graphics of product models were available for viewing on computers with Mastercam or ANSYS programs showing that the

performance of product models in real environments can be analyzed on computers. Both data results and graphic results were viewed and analyzed by designers and engineers. According to the results, changes can be made to the product models and the newer version can be analyzed again. So, time, labor and money can be saved by eliminating the process for experimental tests. This also shortens the time used for product modeling and improves the quality of products, ensuring that the new products can be produced to satisfy customers' requirements as soon as possible. This important factor allows manufacturers to compete efficiently in the worldwide economic environment.

Another factor that improved the efficiency of this LAN was the network management system. The operating system of the LAN, Windows 2000, used the Distributed file system (Dfs) to manage the product information. In the Dfs system, five shared folders were created in different computers, linked to the Dfs root and distributed throughout the LAN. Users, who logged onto the domain with access permission, were allowed to access the shared folders just as they access the folders on the local computer. Product information was saved and managed in the Dfs system. Users saved their files into assigned folders and gathered other product information from the Dfs system even without leaving their seats. Team leaders and managers shared and managed the product information by accessing those folders that assigned special permissions.

Secure

The LAN is physically composed of several computers connected together with a hub. Logically, it is a domain controlled by domain controllers and has secure structure and rules inside, providing high security for the product information process.

First, two domain controllers were established in the Project.com domain. The additional domain controller, IET-3B.Project.com, provided extra reliability for the domain. If one domain controller was down or encountered fatal problems, the Project.com domain still worked properly and users could logon to it as if nothing had happened. Also, the additional domain controller provided database backup for the domain controller. The Active Directory, installed in the domain, was set up to automatically replicate any changes made to the database of the first domain controller onto the additional controller's database every five minutes. Other methods of database backup could also be applied for multiple securities, such as floppy disks, tapes, zip disks, and CDs.

Second, the secure account management prevented unauthorized logons to the Project.com domain. The following factors were specified for each user's account.

Username

Logon name

Password

Logon computers

Logon time.

When a user logged onto the domain, they were also required to type in the domain name. Any violation to the configured policy failed logons. Additionally, the network administrator set strict rules for the accounts of users, such as changing passwords.

Third, file permissions, together with the Dfs system, set high security to the product information process. The Dfs root was not displayed in either control panel or network neighborhood. The only way to access it was to type in the Dfs root name and domain name in the network address box. The access permissions for the shared folders in the Dfs system were set by the administrators for each user. Different users were assigned different levels of permission to different folders. For example, designer02 (team member) had full control permission to shared folder Mastercam and read only permission to shared folder Admin-D, designer01 (team leader) had full control permission to both folders.

Scalable

The LAN is capable of growth for the future use of the manufacturer. Computers and network devices can be added to the LAN for more designers and engineers to use. Adding more client computers to the Project.com domain could be an easy process. As the LAN becomes bigger and more powerful, the database can even be separated from the domain controller. Another server could be added to the domain to act as a file server to handle database management only. This would allow the domain controllers to have more space and capability to deal with the user accounts and network management.

By using Windows 2000 as the network operating system, the logic structure of the domain can be extended when more complicated management is needed. As the designing and analyzing departments grow, more teams and more team members will use the domain and the relationship between teams will become more complicated. Domains, sub-domains, and trees can be created on the network to ensure secure and efficient information management.

Designing and analyzing tools can be updated without influencing the LAN's operation as technology develops newer versions of software with more powerful functions.

The LAN was set up to handle the creation of a WAN. As the company grows, other departments will probably be established in remote cities to meet market requirements and other LANs will be setup in these remote locations. Integrating the LANs into one WAN would then be the best choice to meet the information exchange demands between the companies for daily operations.

Disadvantages of the LAN

Disadvantages of the LAN network exist, creating load works to the achievements of the manufacturers' efficiency. Specific persons must maintain both the hardware and software of the LAN, users must be trained, and a high initial investment is required for the construction of the LAN.

Since the product information is generated and managed on the network, the proper product information flow depends on the proper performance of the hardware and software of the LAN. There must be at least one professional employee with

enough network technology and experience to help construct and maintain the LAN. Detailed documentation about the hardware and software used on the LAN should be generated and kept for future reference. The network must always be monitored to prevent network traffic and node corruption.

All designers, analyzers, engineers and managers, who intend to use the LAN, need to attend a training program on the network technology to be used. They should have enough knowledge and operating skills to work with the network. Once the LAN is constructed, a training program is necessary for those employees. All of these requirements and the investments on the network equipments create a very high initial investment on the network, and can be very frustrating for the smaller companies.

Mastercam8.1 vs. ANSYS5.7

The two designing and analyzing tools integrated into the LAN were Mastercam8.1 and ANSYS5.7. They played different roles in the product modeling process as well as had the ability to communicate and cooperate with each other. In this study, several features of their functions and co-operations were experienced through the simulation.

Mastercam8.1 is powerful in geometric and toolpath designing. The product model was generated with precise data information and the animation of machining process was displayed. Any mistake that happened to the machining process could easily be seen. Then the product could either be remodeled or the tool could be changed to a different type. The NC code was generated for CNC machining. As long as the post processor corresponded to the CNC machine, the NC code, which was

used to machine the product, was generated from Mastercam. CNC controllers can be added to the LAN to improve the efficiency of file transfer.

ANSYS is a powerful analysis tool for manufacturing. It can also be used to generate the geometric model of the product, but it does not program as well as Mastercam. In this study, an attempt was made to convert the product data file that was generated from ANSYS to Mastercam. The data file conversion and transfer to Mastercam failed when the model was deformed because of imprecise data from ANSYS designing. So, ANSYS was used only for the analyzing part of this study.

An important and fatal factor for the co-operating between Mastercam8.1 and ANSYS5.7 is the file conversion between them. This is also a keystone for my study. Both Mastercam8.1 and ANSYS5.7 have file converters integrated into the programs. The Initial Graphic Exchange Specification (IGES) file is the file type that software packages can read from, write to and use for graphic conversions. When converting files by IGES, these important operation rules should be followed.

1. It is best to import product data from Mastercam to ANSYS by using the converter integrated in Mastercam8.1.
2. Only graphic data files can be converted without deformation. Don't try to convert data files with toolpath specified.
3. For both Mastercam and ANSYS, the same units should be applied for measurement.
4. Pay attention to the coordinate system of the graphic model of the product.

For precise data transfer between the two programs, the process of converting the file is not as simple as just click on the converter button in the main menu. Many works should be done before and after the converting. This is a crucial phase for product modeling; otherwise the analysis results will be useless.

Nowadays, there are newer versions of IGES tools produced for 2D and 3D translating between CAD/CAM and ANSYS, such as STEP, CADLINK, and IGES 6.0. They help ANSYS to import graphic files from CAD/CAM programs in a more precise way. Integrating these kind of programs into the LAN should be considered for future use. This will bring an optimal performance of the co-operating between Mastercam and ANSYS.

Suggestions and Recommendations

This study is only a beginning experimental research on integrating a network into a manufacturing system. There are several suggestions and recommendations for further study.

1. The next step for further study should be to connect the LAN to the Internet. VLAN or WAN can be applied in a manufacturing system as well as in a business.
2. Further studies on Mastercam and ANSYS should be done to optimize their performance on a network.
3. With the Windows 2000 network operating system, a web site could be established for more efficient and direct information management.

4. More research needs to be completed on the graphic file conversion between Mastercam8.1 and ANSYS5.7 to optimize the co-operation between them.

Summary

As the last chapter of this Thesis, findings throughout the experimental study were summarized. Advantages and disadvantages of the LAN were discussed. Several problems were demonstrated as well as recommendations for further studies.

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